mercruiser

SERVICE MANUAL

Number 1

Stern Drive Units and Marine Engines

Book 1 of 2
Sections 1 thru 5

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Notice to Users of This Manual

This service manual has been written and published by the service department of Mercury Marine to aid our dealers' mechanics and company service personnel when servicing the products described herein.

It is assumed that these personnel are familiar with the servicing procedures of these products, or like or similar products manufactured and marketed by Mercury Marine. That they have been trained in the recommended servicing procedures of these products which includes the use of mechanics common hand tools and the special Mercury Marine or recommended tools from other suppliers.

We could not possibly know of and advise the service trade of all conceivable procedures by which a service might be performed and of the possible hazards and/or results of each method. We have not undertaken any such wide evaluation. Therefore, anyone who uses a service procedure and/or tool, which is not recommended by the manufacturer, first must completely satisfy himself that neither his nor the product's safety will be endangered by the service procedure selected.

All information, illustrations and specifications contained in this manual are based on the latest product information available at time of publication.

It should be kept in mind, while working on the product, that the electrical system and ignition system is capable of violent and damaging short circuits or severe electrical shocks. When performing any work where electrical terminals could possibly be grounded or touched by the mechanic, the battery cables should be disconnected at the battery.

Any time the intake or exhaust openings are exposed during service they should be covered to protect against accidental entrance of foreign material which could enter the cylinders and cause extensive internal damage when the engine is started.

It is important to note that, during any maintenance procedure, replacement fasteners must have the same measurements and strength as those removed, whether metric or customary. (Numbers on the heads of the metric bolts and on surfaces of metric nuts indicate their strength. Customary bolts use radial lines for this purpose, while most customary nuts do not have strength markings. Mismatched or incorrect fasteners can result in damage or malfuction, or possibly personal injury. Therefore, fasteners removed should be saved for re-use in the same locations whenever possible. Where the fasteners are not satisfactory for re-use, care should be taken to select a replacement that matches the original.

Replacement Parts

⚠WARNING

Electrical, ignition and fuel system components on MerCruiser Engines and Stern Drives are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire or explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply to these rules and regulations, could result in a fire or explosion hazard and should be avoided.

When servicing the electrical, ignition and fuel systems, it is extremely important that all components are properly installed and tightened. If not, any electrical or ignition component opening would permit sparks to ignite fuel vapors from fuel system leaks, if they existed.

Engine Mechanical Components

Many of the engine mechanical components are designed for marine applications. Unlike automotive engines, marine engines are subjected to extended periods of heavy load and wide-open-throttle operation, therefore, require heavy-duty components. Special marine engine parts have design and manufacturing specifications which are required to provide long life and dependable performance. Marine engine parts also must be able to resist the corrosive action of salt or brackish water that will rust or corrode standard automotive parts within a short period of time.

Failure to use recommended Quicksilver service replacement parts can result in poor engine performance and/or durabiltiy, rapid corrosion of parts subjected to salt water and possibly complete failure of the engine.

Use of parts other than recommended service replacement parts will void the warranty on those parts which are damaged as a result of the use of other than recommended parts.

MODELS COVERED IN THIS MANUAL

MERCRUISER STERN DRIVE ENGINES (MCM)	
Model	**Serial Number**
MCM 60	All
MCM 80	All
MCM 90	All
MCM 110	All
MCM 120	3770649 and below
MCM 140 (6 Cyl.)	All
MCM 140 (4 Cyl.)	3771644 and below
MCM 150	All
MCM 160	All
MCM 165	3774864 and below
MCM 888	3777489 and below
MCM 190 (V-8)	All
MCM 200 (6 Cyl.)	All
MCM 215	All
MCM 225 (G.M.)	All
MCM 225TR (Ford)	3779774 and below
MCM 250 (327 CID)	4767999 and below
MCM 255TR (Ford)	3838787 and below
MCM 270	All
MCM 310	All
MCM 325	All
MCM 390	All

MERCRUISER INBOARD ENGINES (MIE)	
Model	**Serial Number**
MIE 30	All
MIE 55	All
MIE 215	All
MIE 225 (G.M.)	All
MIE 225 (Ford)	3750507 and below
MIE 250 (327 CID)	4767999 and below
MIE 255 (Ford)	3839487 and below
MIE 270	All
MIE 325	All
MIE 390	All

TRANSOM ASSEMBLY AND STERN DRIVE UNITS	
Model	**Serial Number**
MCO	All
MCI	All
MCIA/B/C	All
MCIA/B/C E-2	All
MC 80	All
MC 90	All
MC 120	3780849 and below
MC 140	3780849 and below
MC 160	All
MC 165	3780849 and below
MC 888	3784374 and below
MCM 215 H	All
MCM 215 E	All
MC TR	3787239 and below
MCII	All
MC III	All

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MCIA/B/C E-2	All
MC 80	All
MC 90	All
MC 120	3780849 and below
MC 140	3780849 and below
MC 160	All
MC 165	3780849 and below
MC 888	3784374 and below
MCM 215 H	All
MCM 215 E	All
MC TR	3787239 and below
MCII	All
MC III	All

MERCRUISER SERVICE MANUAL OUTLINE

SECTION NO.	SECTION HEADING	
1	**General Information**	Part A - General Information Part B - Tuneup Part C - Lubrication
2	**Removal-Installation-Alignment**	Part A - MerCruiser 60-80-90 Part B - MerCruiser I Part C - MerCruiser II Early Part D - MerCruiser II Transom Part E - MerCruiser III Part F - MerCruiser 215H Part G - MerCruiser 215E Part J - MerCruiser II-TR Drive Unit
3	**Electrical System**	Part A - Starting System Part B - Ignition System Part C - Alternator System Part D - Instrumentations Part E - Wiring Diagrams
4	**Fuel Systems**	Part A - Fuel Pumps Part B - Carburetors
5	**Engine**	Part A - Engine Mechanical, In-Line GM Part B - Engine Mechanical, In-Line 60-80-90 Part C - Engine Mechanical, V-8 GM Part D - Engine Mechanical, V-8 Ford
6	**Drive Systems**	Part A - MerCruiser 60-80-90 and MerCruiser I Part B - MerCruiser II Part C - MerCruiser 215 Part D - MerCruiser III Part E - Direct Drive Transmission Part F - MerCruiser II-TR Drive Unit Part G - MerCruiser II-TR Transmission
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8	**Specifications**	
9	**Tools**	

MERCRUISER

SECTION 1

GENERAL INFORMATION

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SECTION 1 - GENERAL INFORMATION

MERCRUISER

PART A - GENERAL INFORMATION

MERCURY MARINE

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GENERAL INFORMATION

HOW TO USE THIS MANUAL

This comprehensive overhaul and repair manual is designed for mechanics to use as a reference guide.
The manual is divided into SECTIONS which represent major components and systems. Following are the SECTIONS which compose this manual:

Section	Section Heading
1	General Information
2	Removal, Installation and Alignment
3	Electrical Systems
4	Fuel Systems
5	Engine
6	Drive Systems
7	Accessories
8	Specifications
9	Tools
10	Flat Rate Manual/Service Bulletins *(Dealers Only)*

SECTIONS are separated by dividers (heavier color paper) which enable the user to quickly locate any desired SECTION. A table of contents, which lists major subjects and page numbers, is printed on the reverse side of each SECTION divider.

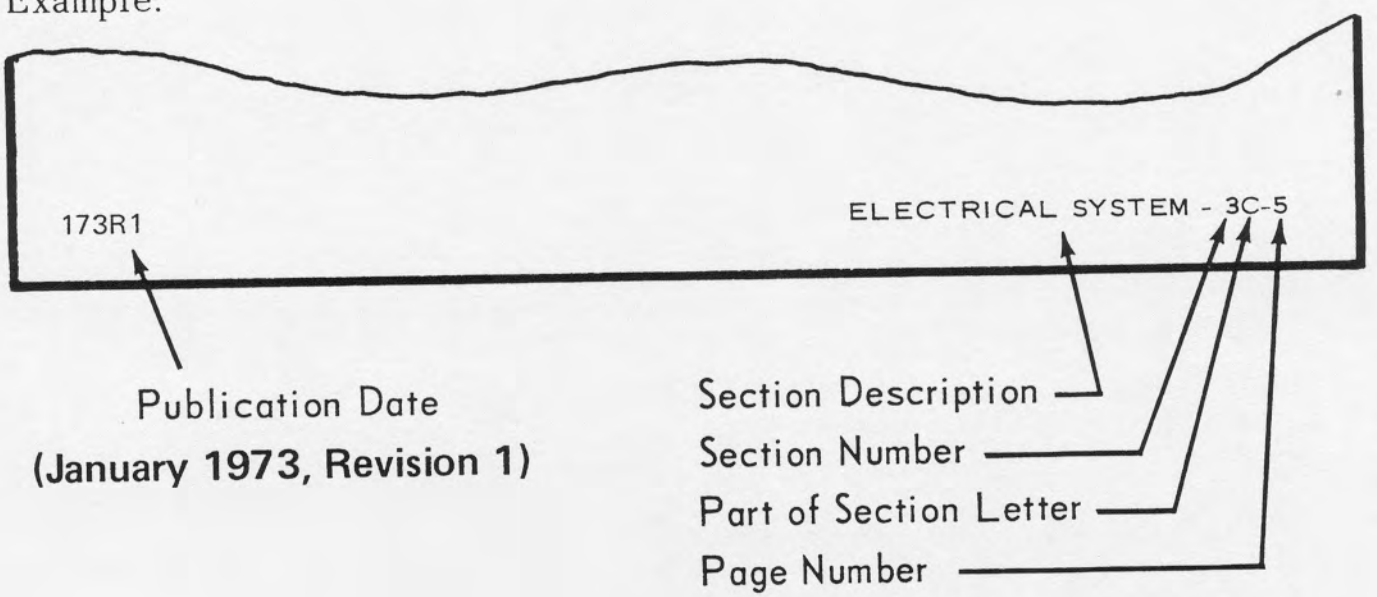
The SECTIONS are further divided into PARTS. Each PART has a colored title page which is the same color as the SECTION divider. An index for the particular PART is printed on the title page.

EXAMPLE: To find "Integral Charging System", turn to "Electrical Systems" divider. The table of contents on the back side of the divider indicates that "Integral Charging System" is located in PART C, "Alternator System", Page 3C-13.

PAGE NUMBERING

Two number groups appear at the bottom of each page. The example, below, is self explanatory.

Example:



DIRECTIONAL REFERENCES

Front of boat is bow; rear is stern. Starboard side is right side; port side is left side. In this maintenance manual, all directional references are given as they appear when viewing boat from stern, looking toward bow. (Figure 1)

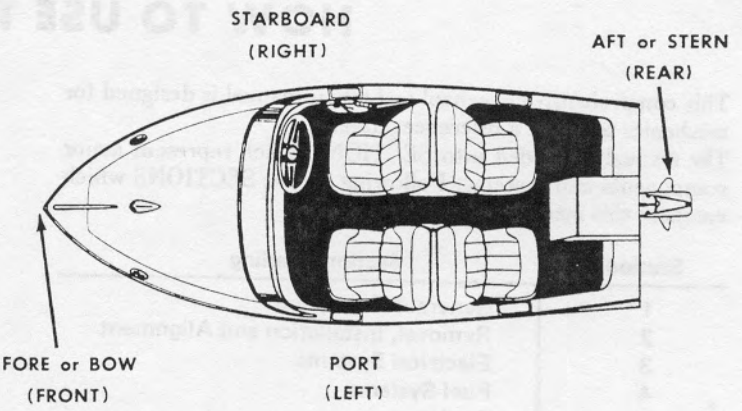


Figure 1. Directional Reference

ENGINE ROTATION TERMINOLOGY

Engine rotation is determined by observing crankshaft rotation from the rear of engine looking forward.

All MerCruiser stern drive engines are left hand rotation.

Inboard engines can be either left or right hand rotation.

Do not rely on propeller rotation, as propeller rotation is not, necessarily, the same as engine rotation.

ENGINE SERIAL NUMBER

IMPORTANT: Serial numbers are the manufacturer's key to numerous engineering details applicable to the engine. When ordering parts, accessories and tools, or when corresponding with the manufacturer or dealer in regard to service matters, always specify engine serial number.

MERCRUISER 60

Serial number is located on left side of engine block above oil filter. (Figure 2)

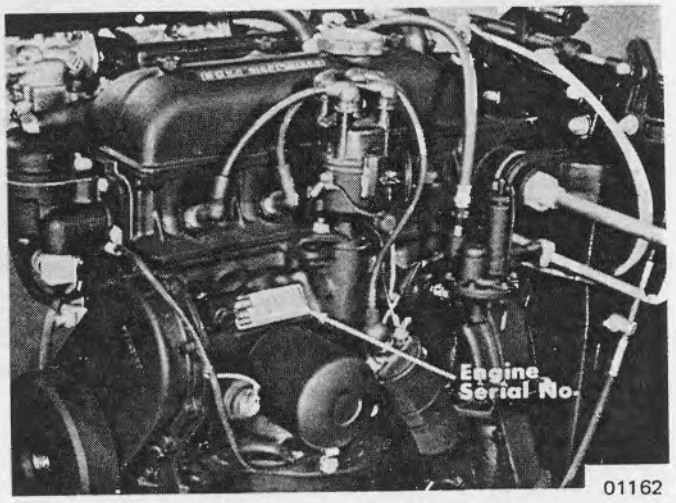


Figure 2. MerCruiser 60 Serial No. Location

Figure 3. MerCruiser 80 and 90 Serial No. Location

MERCRUISER 80 and 90

Serial number is located on rear left side of engine block under intake manifold. (Figure 3)

MERCRUISER 120-140-160-165-225

Serial number is located on rear right side of engine block above starter motor. (Figure 4)

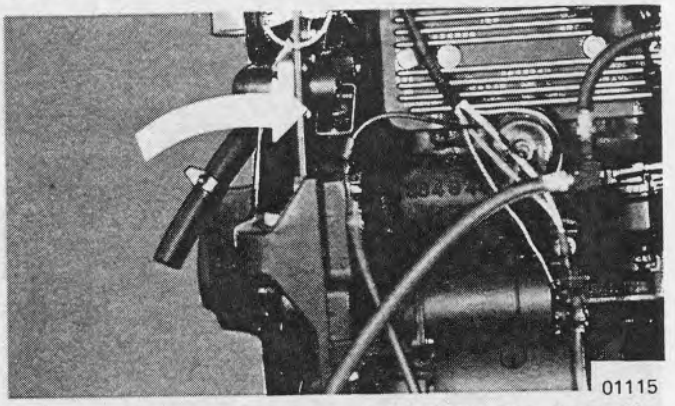


Figure 4. MerCruiser 120-140-160-165-200-225 Serial No. Location

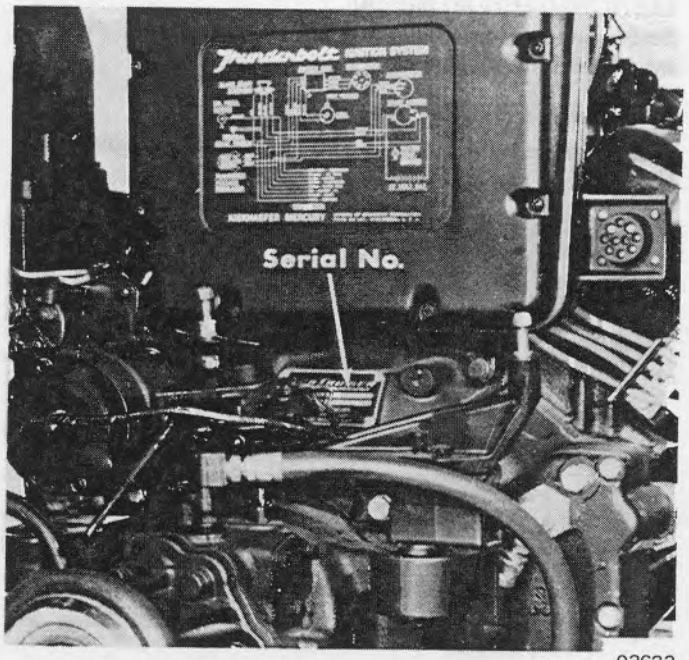
MERCRUISER 888-215-225II-TR and 255II-TR

Serial number is located on rear top of cylinder block between intake manifold and flywheel housing. (Figure 5)

Figure 5. MerCruiser 888-215-225II-TR and 255II-TR Serial No. Location

MERCRUISER 325

Serial number is located at rear of engine on fly wheel housing. (Figure 6)

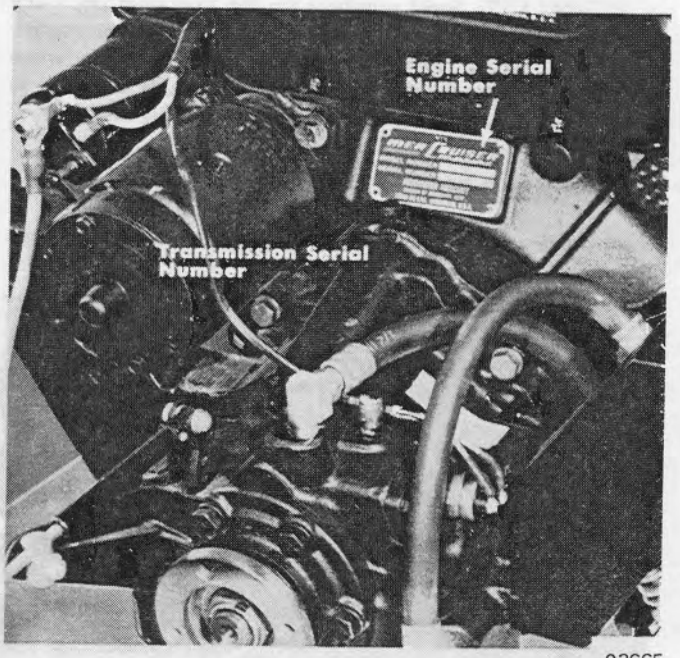


03623

Figure 6. MerCruiser 325 Serial No. Location

INBOARD ENGINES

Serial number for all inboard engines is located at rear of engine on fly wheel housing. (Figure 7)



03665

Figure 7. Inboard Engine Serial No. Location

STERN DRIVE SERIAL NUMBERS

IMPORTANT: Serial numbers are the manufacturer's key to numerous engineering details applicable to the unit. When ordering parts, accessories and tools, or when corresponding with the manufacturer or dealer in regard to service matters, always specify stern drive serial number.

NOTE: A pressure-sensitive decal is enclosed with the stern drive. Decal should be placed on side of engine cylinder head rocker cover.

MERCRUISER I and "O"

The serial number of MerCruiser I and "O" Stern Drive Units are located as follows:

1. Beneath MerCruiser decal embossing on either side of drive shaft housing. (Figure 1)
2. On drive shaft housing to bell housing mounting flange. (Figure 1)
3. On and under MerCruiser decal on either side of drive shaft housing. (Figure 1)

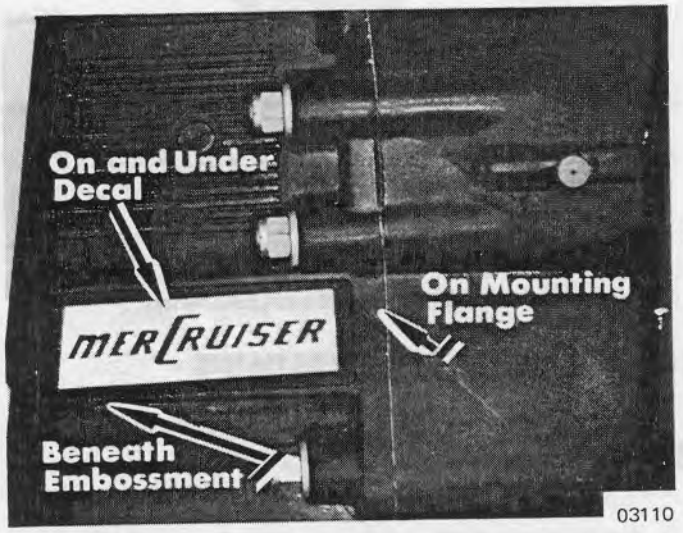


Figure 1. MerCruiser I and "O" Serial No. Location

MERCRUISER 888

Stern drive unit serial number is stamped on drive shaft housing under MerCruiser decal on either side of housing. (Figure 2) Serial number also is on the 888 decal on rear of drive shaft housing. (Figure 2)

MERCRUISER II

Stern drive unit serial number is stamped on serial plate on front of steering lever housing. (Figure 3)

MERCRUISER III-215-225II-TR and 255II-TR

Stern Drive Unit serial number is embossed on the MerCruiser decal (located on left or right side of drive unit). This number also is stamped on drive shaft housing, directly under MerCruiser decal. (Figure 4)

Figure 2. MerCruiser 888 Serial No. Location

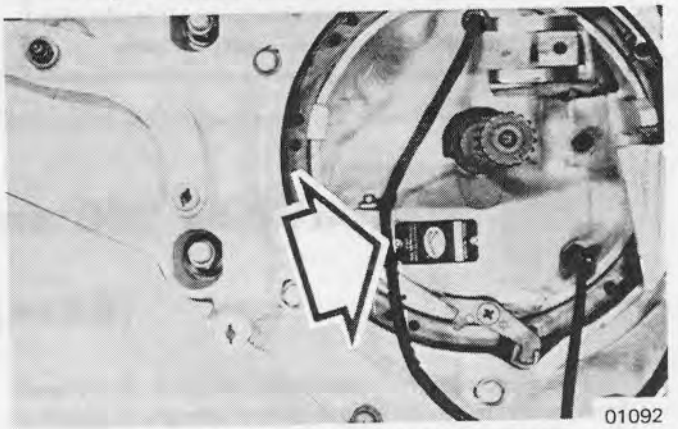


Figure 3. MerCruiser II Serial No. Location

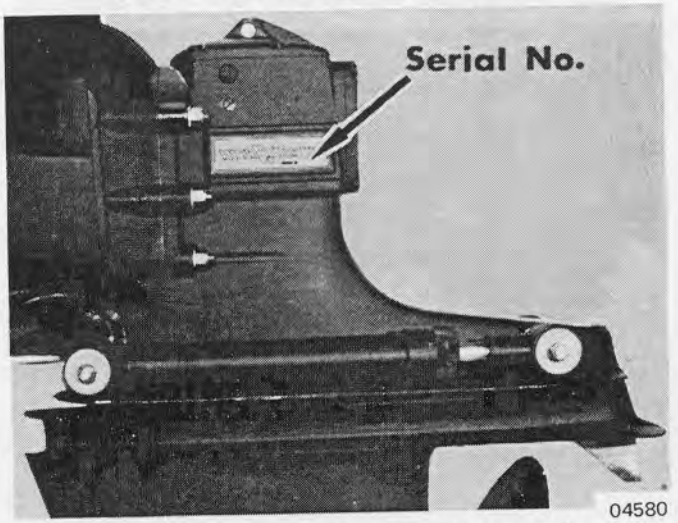


Figure 4. MerCruiser III-215-225II-TR and 255II-TR

FLUSHING COOLING SYSTEM

MERCRUISER 60-80-90 and 4 and 6-CYLINDER ENGINES (Except 200) and 888

NOTE: When engine is operated in salt or silt water, it is recommended to flush engine with fresh water periodically and before storage.

CAUTION: Engine must be operated while flushing. To prevent damage to water pump impeller, attach a Flush-Test Device directly over intake holes in gear housing strut to provide cooling water at this point. (Figure 1) DO NOT OPERATE above idle speed while flushing with Flush-Test Device. See your local dealer for this device.

MerCruiser 888 engines with FRESH WATER COOLING are equipped with seawater pump (located on engine) in addition to seawater pump in drive unit. Cooling water MUST BE supplied to BOTH pumps to prevent damage to water pumps' impellers.

WARNING: When flushing, be certain that area in vicinity of propeller is clear and that no person is standing nearby, to avoid possible injury. It is advisable to remove propeller as a precautionary measure.

1. Install Flush-Test Device. Connect garden hose between it and water tap.

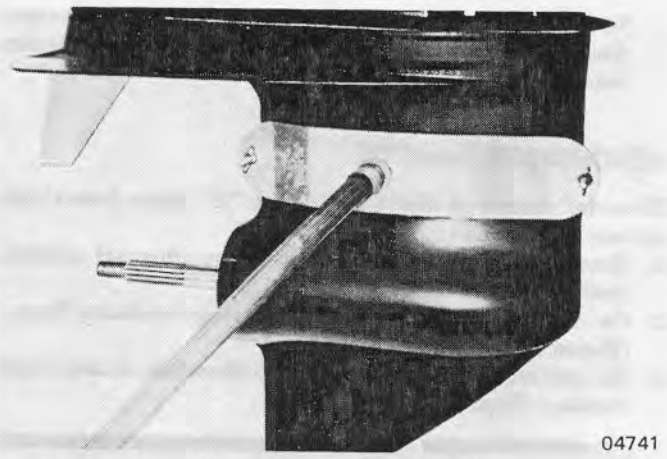


Figure 1. Flush Test Device

2. Partially open water tap. DO NOT use full city water pressure.
3. Shift into neutral gear and run engine at 500-600 RPM to circulate water until engine reaches normal operating temperature. Watch water temperature gauge to prevent overheating. Flush until discharged water is clear, THEN STOP ENGINE.
4. Close water tap and remove Flush-Test Device.

MERCRUISER 200 and 8-CYLINDER ENGINES (Except 888)

NOTE: When engine is operated in salt water, flush it with fresh water periodically and before storage. If engine is flushed while boat is in water, water intake must have a sea water cock installed between water pickup and pump inlet.

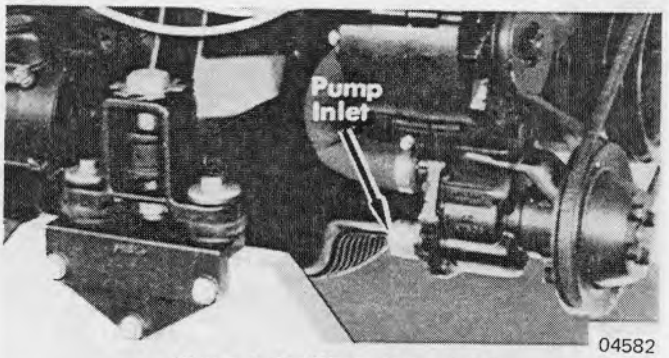


Figure 2. Sea Water Pump Inlet

1. Close sea water cock (if flushed while boat is in water).
2. Remove hose clamp and hose from water pump inlet.

CAUTION: Do not operate engine without cooling water flowing through water pump, or neoprene water pump impellers will become damaged.

3. Connect length of hose to pump inlet and city water tap. Partially open tap. Do not use full city water pressure.
4. Place remote control handle in neutral position and start engine. Be sure that no one is near propeller. Operate engine at 500 to 600 RPM in neutral gear to circulate water until engine reaches normal operating temperature.
5. Check that water is being discharged out exhaust outlets and watch water temperature gauge on instrument panel to prevent overheating.
6. Allow engine to run until discharged water is clear.
7. Stop engine and remove flushing hose. Fasten water intake line securely to pump inlet with hose clamp. (Figure 2)
8. Open sea water cock.

WINTER STORAGE - MARINE ENGINES

Cylinder blocks suffer horizontal cracks when water freezes in the block. These freeze cracks are caused by failure to drain the cylinder block and exhaust manifold for winter storage in anticipation of freezing weather. Four and 6-cylinder blocks crack on sides of the engine, just below the core plugs or along the upper edge below the cylinder head.

Eight-cylinder blocks usually crack in the area near the hydraulic lifters or below the intake manifold in the valley of the block. If freezing failure is indicated or water is found in the crankcase, remove the intake manifold to check these areas.

NOTE: For closed cooling system maintenance, refer to Section 7D "Cooling".

MERCRUISER 60-80-90

WARNING: Do not operate engine without cooling water flowing through water pump, or water pump will be damaged.

1. Run engine until normal operating temperature is reached, then shut down.
2. Drain engine oil and replace oil filter.
3. Refill crankcase with fresh SAE 30 MS oil. Add 8 ounces of Quicksilver 4-Cycle Engine Oil Supplement (C-92-33365, 16 ounce [.473 liter] can) to oil.
4. Shut fuel supply off at fuel tank.
5. Remove flame arrestor and start engine. With engine running at fast idle (800-1200 RPM), slowly pour 4 ounces (.118 liter) of Quicksilver Storage Seal (C-92-28143) or, if not available, 4 ounces of SAE 30 MS oil (for MerCruiser 80 and 90 and 8 ounces of oil for MerCruiser 60) into carburetor throat while engine is running fuel out of carburetor, fuel pump and lines. Stall engine by pouring last two (2) ounces of oil rapidly into carburetor.

WARNING: Be sure that engine compartment is well ventilated -- and that there are no gasoline vapors present during this operation -- to prevent a potential fire hazard.

6. Remove spark plugs and squirt one ounce of Quicksilver Storage Seal or SAE 30 MS oil into each cylinder. Crank engine for 15 seconds with starter to coat cylinder walls.
7. Disconnect battery leads, remove battery and store as specified by battery manufacturer. Clean and service battery supports, container and cables as required.
8. Condition or replace spark plugs. Remove excess oil from around spark plug holes and install plugs.
9. Clean flame arrestor and reinstall.
10. Drain all gasoline from fuel tank.
11. Replace fuel filter.
12. Remove rocker arm cover. If condensation has collected in cover compartment, carefully wipe away all traces of oil-water mixture. Liberally coat valve mechanism and inside of cover with Quicksilver Storage Seal or SAE 30 MS oil. Reinstall cover, using new gasket.
13. On 80 and 90 engine, the cooling system is self-draining thru a check valve which is located on the right, rear side of the engine block, next to hydraulic pump. (Figure 1) To be sure that valve is not plugged with foreign material, which could prevent cooling system from draining, proceed as follows for 80 and 90 engine.
    a. Position bow of boat so that it is higher than stern. Rear of engine must be lower than front to provide complete draining.

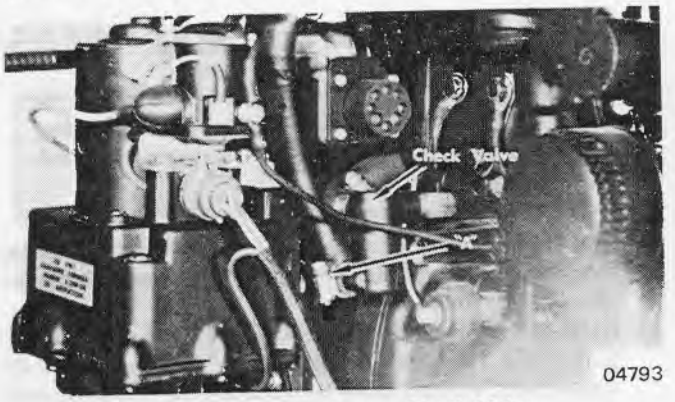


Figure 1. Cooling System Check Valve

    b. Loosen hose clamp on hose "A" in Figure 1 and remove hose from check valve.
    c. Insert a short length of wire into valve to be sure that valve is not plugged.
    d. Remove plug from rear of manifold. (Figure 3)
    e. Allow water to drain completely. Reinstall hose and plug.
14. For MerCruiser 60 engine, remove exhaust manifold elbow and cylinder block drain plugs and allow all water to drain out. One plug is located in exhaust manifold elbow toward front and one plug is located in cylinder block on front of engine. (Figure 2, 3 or 4) Both plugs must be removed to drain completely. Reinstall drain plugs and tighten securely so that cooling system will be operable when engine is returned to service. See "Returning Engine to Service", following. For draining closed cooling system, refer to Section 7-D "Accessories".

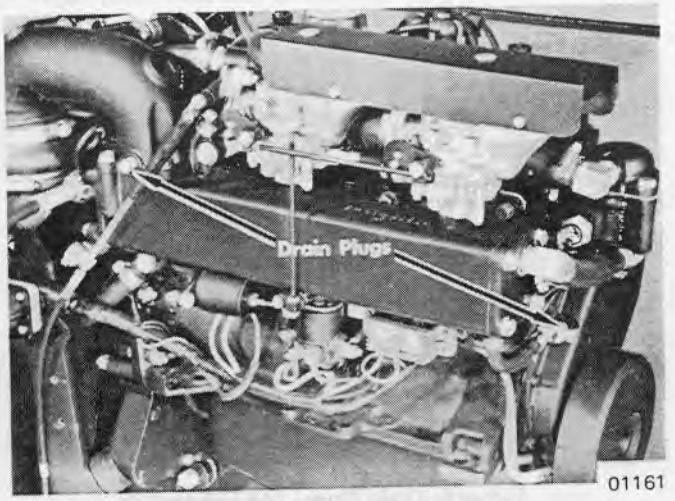


Figure 2. Drain Plug - MerCruiser 60

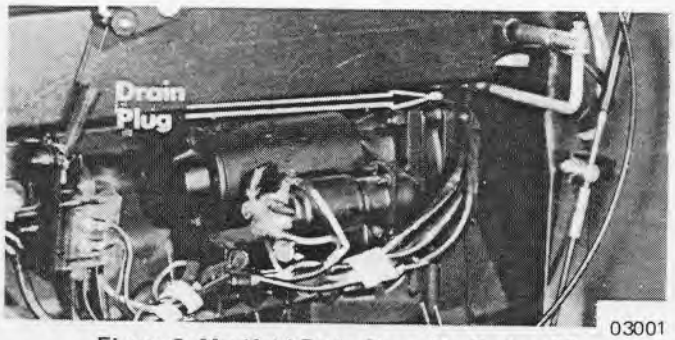


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Figure 3. Manifold Drain Plug - MerCruiser 80

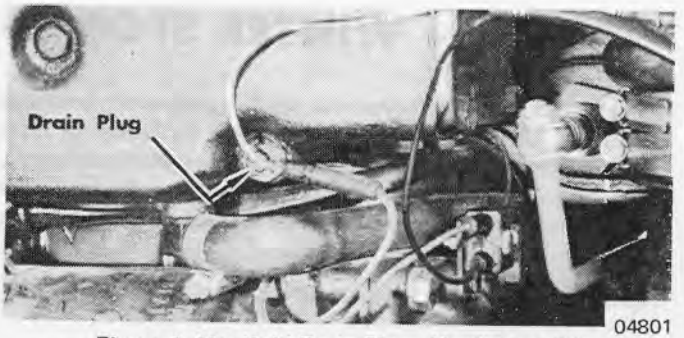

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Figure 4. Manifold Drain Plug - MerCruiser 90

MERCRUISER 110 thru 165

WARNING: Do not operate engine without cooling water flowing through water pump, or water pump will be damaged.

1. Run engine sufficiently to bring it up to normal operating temperature, then shut down and drain crankcase completely and remove oil filter.
2. Refill crankcase with fresh SAE 30 MS oil and add one pint (.473 liter) can of Quicksilver 4-Cycle Engine Oil Supplement (C-92-33365) to crankcase oil at this time and install new oil filter.
3. Shut gasoline supply off at fuel tank.
4. Restart engine and operate for a few minutes at fast idle (800 to 1200 RPM) to be sure that new oil is being well-circulated and that new oil filter cartridge is properly sealed. Stop and recheck oil level to be sure that level is still at "FULL" mark on dipstick. Add oil if necessary.

WARNING: Be sure engine compartment is well ventilated – and that there are no gasoline vapors present during this operation – to prevent a potential fire hazard.

5. Remove flame arrestor and fog internal surfaces of induction system by restarting engine and running at fast idle (800 to 1200 RPM) while slowly pouring Quicksilver Storage Seal (C-92-28143) or, if not available, pour approximately one cup of SAE 30 MS oil into carburetor during the time that the engine is running gasoline out of the carburetor, fuel pump and fuel lines. Stall engine by pouring last two (2) ounces of oil rapidly into carburetor.

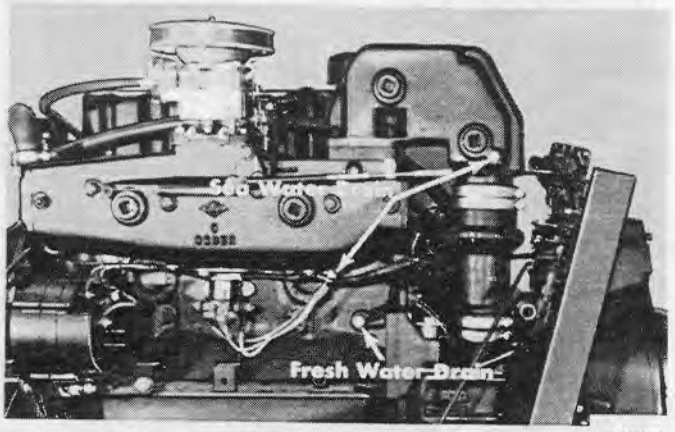

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Figure 5. Drain Plugs - 140-165 Models

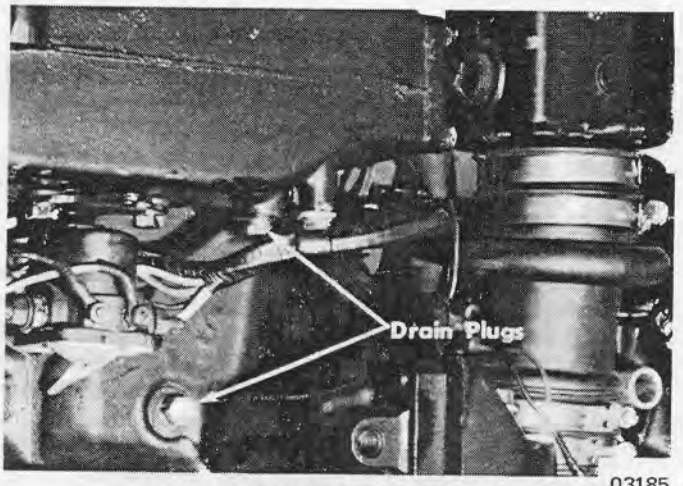

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Figure 6. Drain Plugs - 120 Model

6. Replace fuel filter.
7. Drain all gasoline from fuel tank.
8. Release and inspect alternator and water pump drive belt. Replace if necessary. Reinstall in a loose position.
9. Remove manifold and cylinder block drain plugs. Plugs are located as shown in Figure 5 or 6. All plugs must be removed to drain completely.
   When draining the engine's cooling system, it is necessary that the bow of the boat be higher than the stern, or water may remain trapped in the cylinder block and exhaust manifold. It also is advisable to insert a short piece of wire in the drain holes to be sure that sand, silt or other foreign material is not partially blocking the drain hole. If the engine is not completely drained, the trapped water may freeze and cause severe damage to the engine. For draining closed cooling system, refer to "Accessories" Section 7D.
10. Reinstall drain plugs and tighten securely so that cooling system will be operable when engine is returned to service.
11. Inspect all water hoses for cracks and deterioration and service them as required.
12. For additional insurance against freezing and rust, it is recommended that the cooling system be filled with a solution of permanent anti-freeze and water. Solution should be mixed to the anti-freeze manufacturer's recommended proportion for the lowest temperature to which engine will be exposed while in storage.

NOTE: Refer to Figures 7-8-9 to determine which exhaust manifold and water distribution block is on engine.

Fill cooling system with anti-freeze as follows:

A. Engine Equipped as in Figure 7

1) Remove water intake hose from elbow in manifold body and insert plug in elbow.
2) Remove water outlet hose from relief valve body.
3) Install hose on water distribution block in inverted position. (Figure 7)
4) Pour anti-freeze solution into neck on distribution block until solution rises in neck on relief valve body.
5) Replace hose on relief valve body.

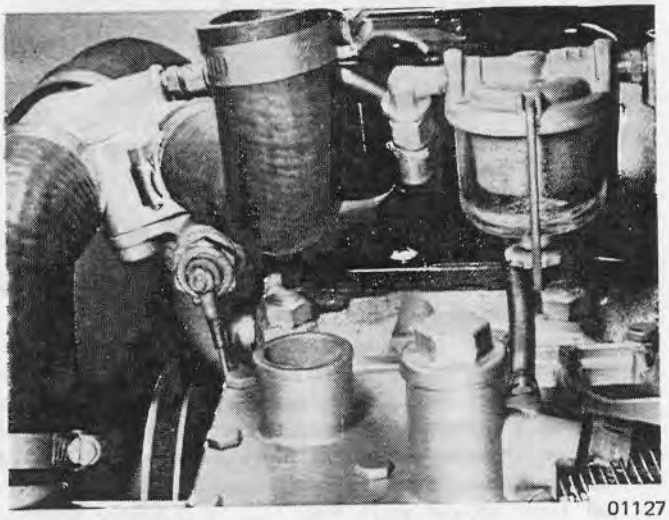

Figure 7. Filling with Anti-Freeze

B. Engine Equipped as in Figure 8

1) Remove water intake hose from elbow in manifold body and insert plug in elbow.
2) Remove hose between distribution block and relief valve body.
3) Pour anti-freeze solution into neck on distribution block until solution rises in neck on relief valve body.
4) Replace hose between distribution block and relief valve body.

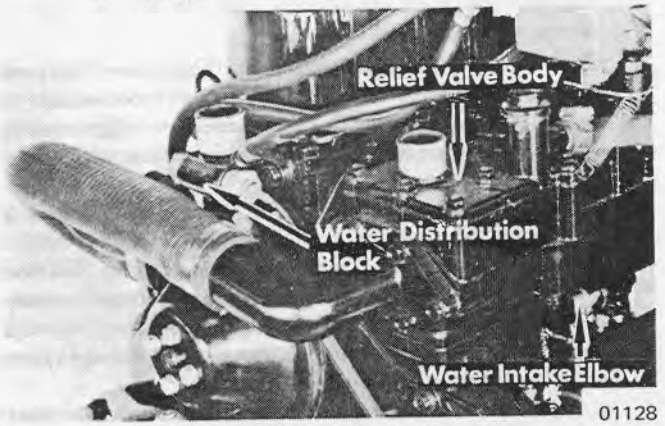

Figure 8. Filling with Anti-Freeze

C. Engine Equipped as in Figure 9

1) Remove water distribution block cover and thermostat.
2) Remove hose from front end cap on manifold.
3) Pour anti-freeze solution into opening in water distribution block until cylinder block, head and manifold are full.
4) Reinstall thermostat, using a new gasket, and connect hose to manifold end cap.

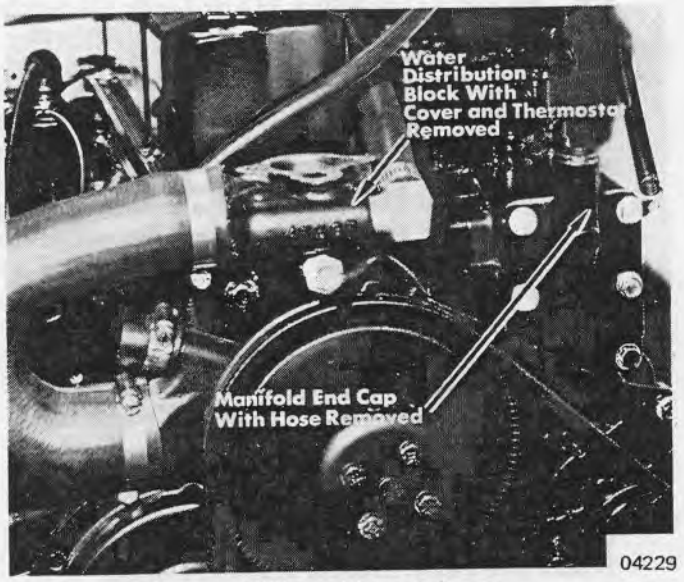

Figure 9. Filling with Anti-Freeze

13. Remove spark plugs from each cylinder and squirt one (1) ounce (.03 liter) of Quicksilver Storage Seal (C-92-28143) or SAE 30 MS oil into each cylinder. Be sure to pull high tension lead out of distributor and ground wire while cranking. With spark plugs removed, crank engine for at least 15 seconds with starter to assure a good coating of oil on cylinder walls. Remove excess oil from around spark plug holes and lightly lubricate spark plug threads.
14. Remove and clean flame arrestor and replace.
15. Remove battery and service as specified by manufacturer. Clean and service battery supports, containers and cables as required.
16. Remove valve rocker arm cover and inspect valve train mechanism for worn or damaged parts. If condensation has occurred in rocker arm cover compartment, carefully wipe away all traces of oil-water mixture, then liberally coat valve mechanism and inside of cover with Quicksilver Storage Seal (C-92-28143) or SAE 30 MS oil. Reinstall cover, using new gasket.
17. Remove oil filler cap and thoroughly clean and re-oil.
18. Clean outside of engine and spray Quicksilver Rust and Corrosion Preventive (C-92-29152) on exterior surfaces of engine or wipe down with rag to leave a very ligh coating of Storage Seal or SAE 30 MS oil on exterior surfaces of engine. Cover engine to prevent direct exposure to weather elements.

WARNING: Do not operate engine without cooling water flowing through water pump, or water pump will be damaged.

1. Drain engine oil and replace oil filter.
2. Refill crankcase with fresh SAE 30 MS oil and one pint (.473 liter) can of Quicksilver 4-Cycle Engine Oil Supplement (C-92-33365).
3. Shut gasoline supply off at fuel tank.
4. Remove flame arrestor and fog internal surfaces of induction system by restarting engine and running at fast idle (800 to 1200 RPM), while slowly pouring Quicksilver Storage Seal (C-92-28143) or, if not available, approximately one cup of SAE 30 MS oil into carburetor during the time that the engine is running gasoline out of the carburetor, fuel pump and fuel lines. Stall engine by pouring last two (2) ounces of oil rapidly into carburetor.

WARNING: Be sure that engine compartment is well ventilated – and that there are no gasoline vapors present during this operation -- to prevent engine fire.

5. Disconnect battery.
6. Drain all gasoline from fuel tank.
7. Release and inspect alternator and water pump drive belt. Replace if necessary. Reinstall in a loose position.
8. Remove cooling system drain plugs. Drain plugs are located as shown in Figure 10 or 11.
   All drain plugs must be removed to drain engine completely. When draining MerCruiser 888, 215, 225 and 255, engine must be level to prevent water from being trapped in cylinder block and manifolds. When draining all other V-8 engines, the front of the engine should be higher than the rear to prevent water from being trapped in the cylinder block and manifolds. It also is advisable to insert a short piece of wire in the drain holes to be sure that foreign material is not partially blocking hole and preventing water from draining completely.
9. Remove water intake hose from sea water pump and allow water to drain. Reinstall hose. Remove circulating pump hose and allow water to drain. Reinstall hose. For draining closed cooling system, refer to "Accessories" Section 7D.

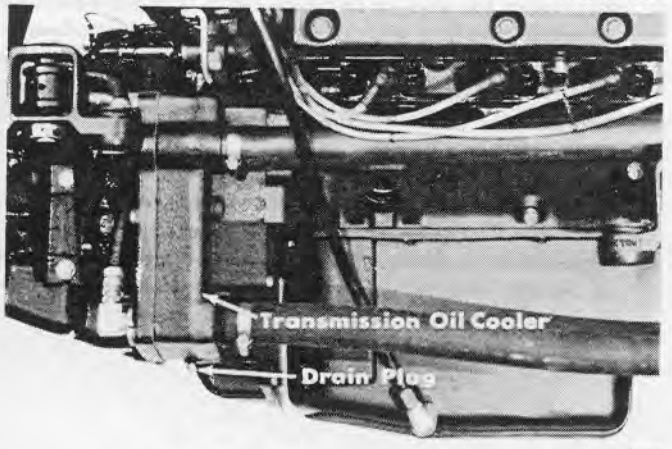

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Figure 10. Transmission Cooler Drain Plug

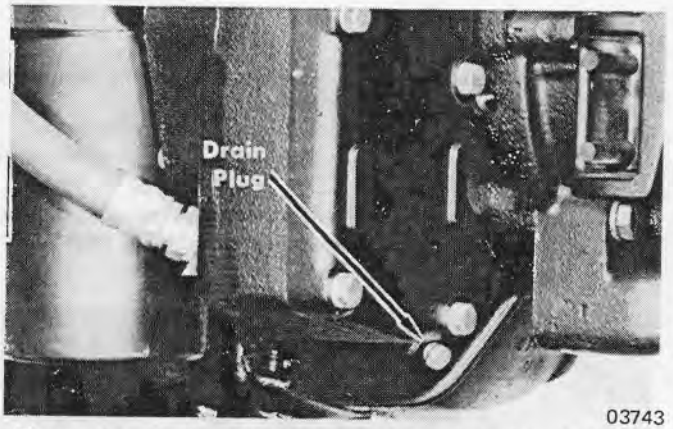

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Figure 11. Engine Oil Cooler and Transmission Oil Cooler Drain Plug - 325 Model

10. Reinstall drain plugs and tighten securely so that cooling system will function when engine is returned to service.
11. Inspect all water hoses for cracks and deterioration and replace them if required.
12. Remove spark plugs and squirt one (1) ounce of Quicksilver Storage Seal (C-92-28143) or SAE 30 MS oil into each cylinder. With spark plugs removed, crank engine for at least 15 seconds with starter to assure a good coating of oil on cylinder walls. Pull high tension lead out of distributor and ground wire while cranking. Remove excess oil from around spark plug holes and lightly lubricate spark plug threads.
13. Service spark plugs. See Section 3 "Ignition".
14. Remove and clean flame arrestor and replace.
15. Remove battery and service as specified by manufacturer. Clean and service battery supports, containers and cables as required.
16. Replace fuel pump inlet filter.
17. Remove valve rocker arm covers. If condensation has occurred in rocker arm cover compartment, carefully wipe away all traces of oil-water mixture, then liberally coat valve mechanism and inside of cover with Quicksilver Storage Seal (C-92-28143) or SAE 30 MS oil. Reinstall covers, using new gaskets.
18. Clean outside of engine and spray Quicksilver Rust and Corrosion Preventive (C-92-29152) on exterior surfaces of engine or wipe down with rag to leave a very light coating of Storage Seal or SAE 30 MS oil on exterior surfaces of engine.
19. For additional insurance against freezing and rust, it is recommended that the cooling system be filled with a solution of permanent anti-freeze and water. Solution should be mixed to the anti-freeze manufacturer's recommended proportion for the lowest temperature to which engine will be exposed while in storage. Fill cooling system as follows: (Figure 12 or 13)
    a. Loosen hose clamps, which fasten hoses to front manifold end caps, and remove hoses.
    b. Remove screws, which fasten thermostat housing cover to housing, and remove cover.
    c. Remove thermostat from housing.
    d. Pour anti-freeze solution into thermostat housing until level comes up to top.

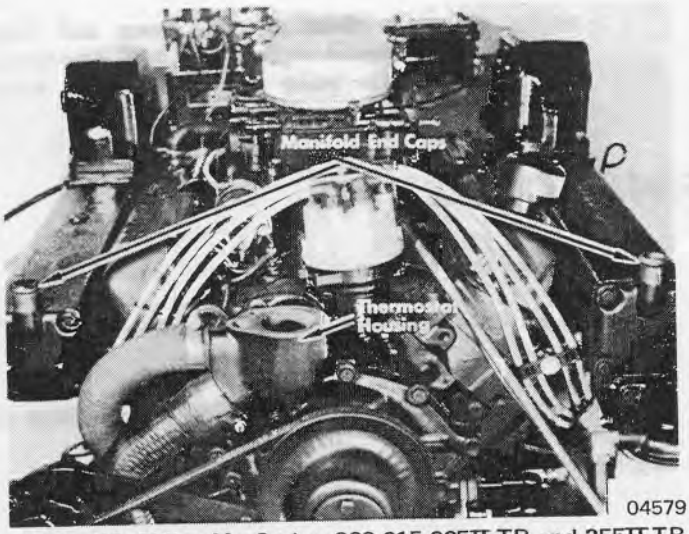

Figure 12. Filling MerCruiser 888-215-225II-TR and 255II-TR with Anti-Freeze

e. Pour anti-freeze solution into opening on each manifold end cap until level comes up to top of end cap. (Figure 12 or 13)

f. On some "V-8" engines, it may be necessary to remove plugs from exhaust manifold (one in each manifold). (Figure 14) Pour anti-freeze solution in each manifold

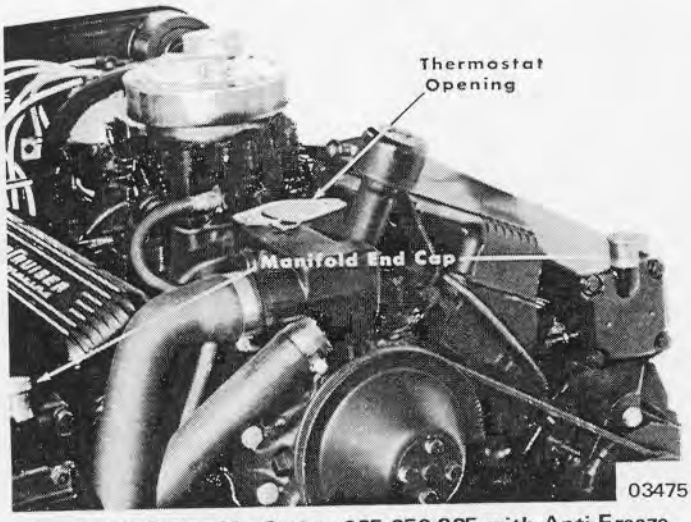

Figure 13. Filling MerCruiser 225-250-325 with Anti-Freeze

until solution is visible. Coat threads on plugs with a thread sealing compound and reinstall plugs. Remove hose which runs from lower water metering housing to engine block water pump. (Figure 15) Pour anti-freeze solution into hose until solution is visible in hose. Reinstall hose and tighten hose clamp securely.

g. Place new gasket on thermostat housing and install thermostat and cover.

h. Connect hoses to manifold end caps.

20. Drain stern drive unit lubricant and refill with new Super-Duty Gear Lubricant (C-92-52650).
21. Lubricate drive unit upper pivot pin.
22. Lubricate steering cable.

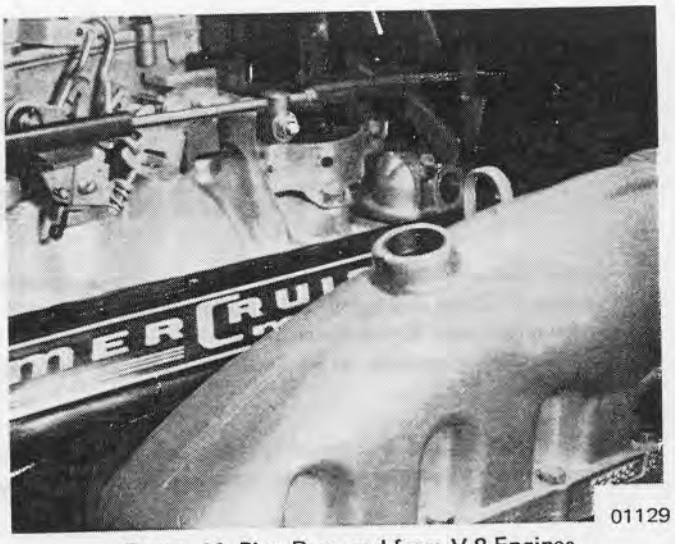

Figure 14. Plug Removed from V-8 Engines

23. Remove propeller, apply Anti-Corrosion Grease (C-92-45134A1) to propeller shaft and reinstall.
24. Wipe exterior of stern drive unit clean and spray with Quicksilver Corrosion and Rust Preventive (C-92-29152).
25. Store stern drive unit in the normal operating position. The universal joint bellows may develop a "set", if unit is stored in a tilted-up position, and result in bellows failure when unit is returned to service. See "Returning Engine to Service", following.

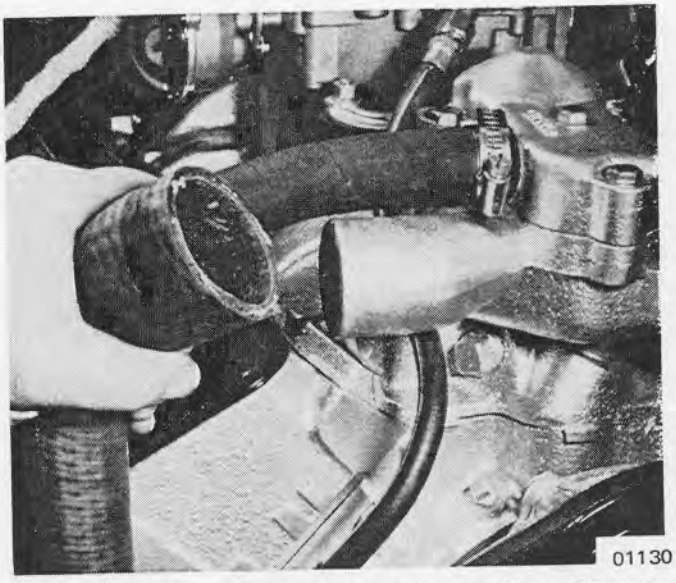

Figure 15. Hose Removed from Lower Water Metering Housing

II-TR TRANSMISSION DRAIN INSTRUCTIONS

In order to prevent damage to transmission oil cooler from freezing water on MerCruiser 225II-TR and 255II-TR Engines, one of the following procedures must be followed.

1. Fill oil cooler with anti-freeze as follows:

   a. On engines with Power Steering, remove Power Steering cooler drain plug. Remove transmission cooler outlet hose from exhaust elbow and pour anti-freeze

into hose (a small funnel may be used) until anti-freeze appears at Power Steering oil cooler. Reinstall Power Steering cooler drain plug and attach hose.

b. Engines without Power Steering: Remove transmission cooler inlet hose from seawater pump and pour anti-freeze into cooler outlet hose until anti-freeze appears at seawater pump end of oil cooler hose. Reattach hoses.

RETURNING ENGINE TO SERVICE

1. Install battery, being sure that it is in a fully-charged condition. Clean and lightly lubricate terminals.
2. Drain anti-freeze, if you desire to save it.
3. Check cooling system to be sure all hoses are properly attached.

NOTE: On 4 and 6-cylinder engines, which have been filled with anti-freeze solution, be sure to remove plug from water intake elbow in manifold and reinstall hose.

4. Readjust drive belt tension, as outlined in "Tune-up" Section I.
5. Check engine alignment.
6. Check engine, stern drive unit and Power Trim pump oil levels.
7. Check engine mount fasteners.

WINTER STORAGE - STERN DRIVE UNITS

It is recommended that the stern drive unit be stored in normal operating position. If the unit is stored in the "tilt-up" position, the bellows may develop a "set" which would result in premature failure when the unit is returned to service.

MERCRUISER I-thru-888

1. Be sure that water drain holes in gear housing are open.
2. Drain stern drive lubricant and refill with Super-Duty Gear Lubricant (C-92-58229-1). Refer to "Draining and Filling Drive Unit", Section 1C.

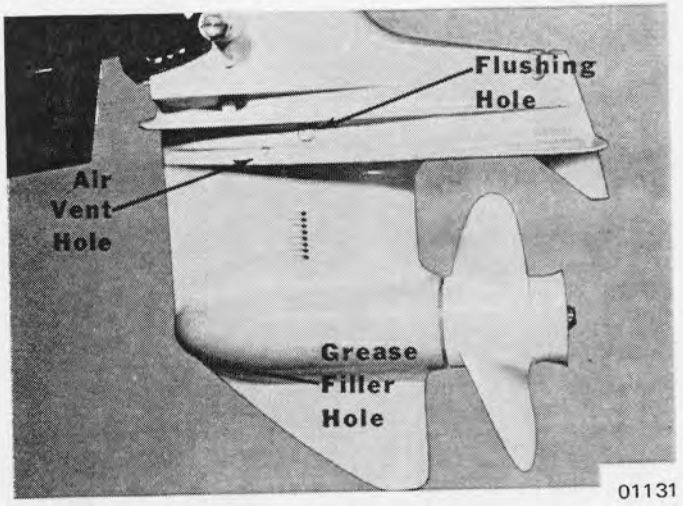

Figure 1. Drain Plug Locations

3. Lubricate following parts with Multipurpose Quicksilver Lubricant (C-92-49588):
   a. Ride-Guide steering cable end.
   b. Pivot socket of steering arm.
   c. Universal joint shaft splines and engine coupling splines.
   d. Drive unit upper and lower pivot pins.
   e. Drive unit hinge pins.
   f. Gimbal bearing, if applicable.
4. Lubricate universal joint bearings with Universal Joint Lubricant (C-92-58299-1).
5. Remove propeller, apply Perfect Seal No. 4 (C-92-34227-1) to propeller shaft and reinstall.
6. Lubricate shift lock shaft with SAE 30 oil, if applicable.
7. Check bellows condition. Replace if necessary.

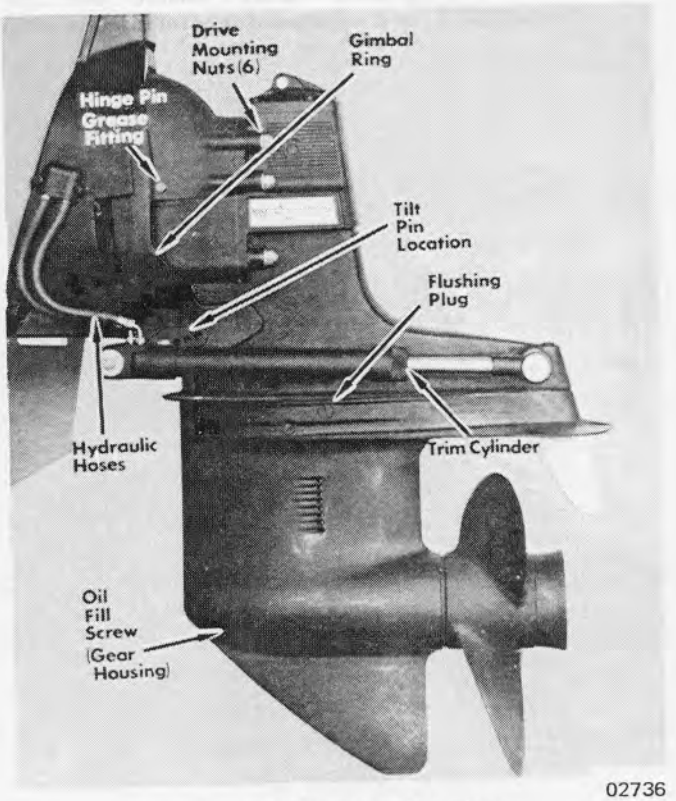

Figure 2. Drain Plug Location

8. Check water pump impeller. Replace if impeller is worn, hardened or set.
9. Check condition of drive unit painted surfaces. Clean and paint metal surfaces that have become exposed. Spray stern drive exterior with Corrosion and Rust Preventive (C-92-29152-12). If applicable, also spray underside of unit in area around reverse locks.
10. At this time, before installing drive unit, check engine alignment as explained in Section 2.

MERCRUISER II-III-215-225II-TR and 255II-TR

1. Check and refill stern drive unit with Super-Duty Quicksilver Gear Lubricant (C-92-52650) before storage. Refer to "Draining and Filling Drive Unit" Section 1, Part C.
2. Lubricate the various MerCruiser Stern Drive components with Quicksilver Multipurpose Lubricant (C-92-49588) and Lubricant Gun (C-91-30500) thru grease fittings:
   1. Inside boat location.
      a. Ride-Guide steering cable end next to hand nut.
      b. Inner transom mounting plate.
         1) Left side at base of crank unit.
         2) Right side top for crank ring gear.
      c. Inside steering lever housing for steering lever shaft.

2. Outside of boat.
    a. Gimbal housing upper and lower pivot pin.
    b. Tilt pins on both sides of gimbal housing.
3. Lubricate universal joint bearings with Universal Joint Lubricant (C-92-58229-1).
4. Check bellows condition and replace if necessary.
5. Before installing drive unit, check engine alignment as explained in Section 2.
6. Remove propeller, apply Perfect Seal No. 4 (C-92-34227-1) or a waterproof-type lubricant to propeller shaft and reinstall propeller. (Refer to "Drive Unit" Section 6)
7. Wipe exterior of stern drive unit clean and spray with Corrosion and Rust Preventive (C-92-29152-12). Also spray underside of unit in area around reverse locks.
8. Store stern drive unit in the normal operating position. The universal joint bellows may develop a "set", if unit is stored in a tilted-up position, and result in bellows failure when unit is returned to service.

TILT PIN ADJUSTMENT

MERCRUISER O-I and II

Holes are provided in the gimbal ring to permit changing location of tilt lock pin for proper adjustment of tilt angle. Tilt angle of stern drive unit on transom should be set so anti-cavitation plate (Figure 1) is about parallel with bottom of boat. Speed of boats, with center of gravity located forward, sometimes may be improved by tilting unit out one pin hole. This will tend to raise bow and reduce wetted surface. If unit is tilted in, boat will ride with bow down, wetting more of the bottom and reducing speed, but generally improving operation in rough water. Operation with excessive tilt out may induce cavitation or cause porpoising of the boat. It is, therefore, preferable to level boat by proper loading rather than by extreme adjustment of tilt angle.

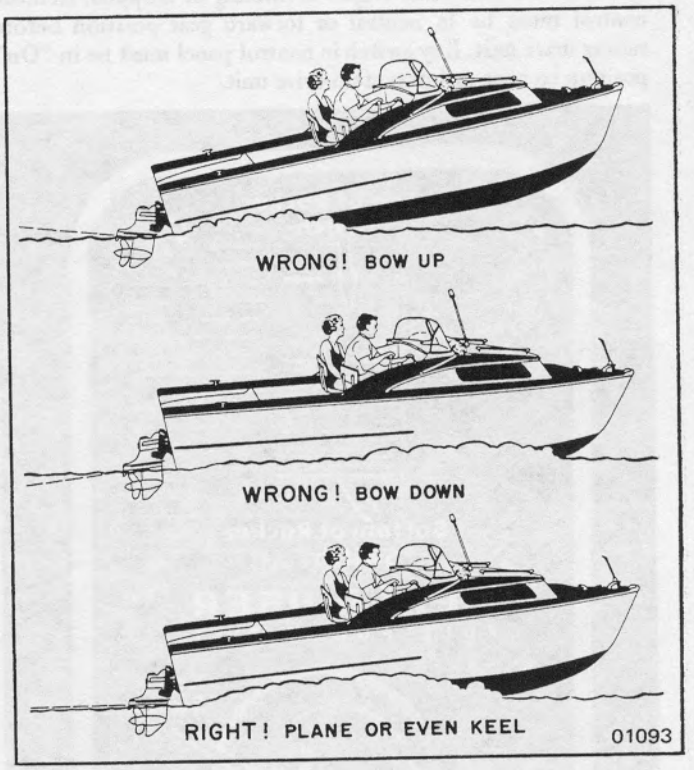

Figure 1. Tilt Angle of Boat

POWER TILT OPERATION

The MerCruiser Full Power Tilt is actuated by switches mounted in control panel. (Figure 2) Stern drive unit may be raised or lowered when engine is running or stopped. Remote control must be in neutral or forward gear position before raising drive unit. Key switch in control panel must be in "On" position to raise or lower stern drive unit.

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Figure 2. Control Panel Switches

To raise drive unit, depress top of rocker switch and hold switch in. To lower drive unit, depress bottom of rocker switch and hold switch in. Reverse lock hook release lever must be in "Lock" position at all times when operating boat. Tilt angle adjustment stud may be positioned in gimbal ring holes, as required, for proper trim when underway. Refer to "Tilt Pin Adjustment", preceding.

IMPORTANT: When drive unit reaches the limit of its upward and downward travel and stops moving, rocker switch should be released. Pump motor is equipped with an overload cutout that will open and, thereby, stop pump motor if rocker switch remains depressed more than 10 seconds after drive unit reaches the end of its travel. If cutout should open, do not depress rocker switch for one minute. After this period of time, cutout will close and unit may be operated.

BOAT at REST

Raising Drive Unit

1. Place remote control lever in neutral or forward position.
2. Turn control panel key switch to "On" position.
3. Push top of rocker switch in and hold until drive unit has tilted up amount desired or reaches end of travel.
4. Turn control panel key switch to "Off" position.

Lowering Drive Unit

1. Turn control panel key switch to "On" position.
2. Push bottom of rocker switch in and hold until drive unit reaches end of travel and reverse lock hooks latch.
3. Turn control panel key switch to "Off" position.

IMPORTANT: Because of presence of the special alloy "trim-tab" at rear base of drive shaft housing, it is recommended that stern drive unit be left in operating position. If trim tab is out-of-water (as when tilted up) it cannot function as a galvanic corrosion inhibitor.

BOAT UNDERWAY

Raising Drive Unit

1. Place remote control lever in neutral or forward gear idle position (500-600 RPM).
2. Turn control panel key switch to "On" position.
3. Push top of rocker switch in and hold until drive unit has tilted up amount desired. (Figure 1)

NOTE: Tilt unit is intended for shallow water operation at low throttle settings. **Do not run at high speed with drive unit tilted out beyond gimbal ring tilt pin flanges, as drive unit has no side thrust support when tilted this high.**

While running, do not tilt unit so high that water intake holes in gear housing strut are lifted out of the water. This would result in overheating of the engine, as indicated by water temperature gauge on instrument panel. A water pressure gauge can be installed on the dash to give a faster indication of loss of water pressure from tilting too high. Serious engine damage may result from overheating.

IMPORTANT: When operating boat with unit tilted up, it is necessary that control panel key is left in "On" position. Safety tilt switch on stern drive unit will not function when control panel key switch is in "On" position and engine will not stop running when drive unit tilts up.

Lowering Drive Unit

1. Push bottom of rocker switch in and hold until drive unit reaches end of travel and reverse lock hooks latch. (Figure 1)
2. Turn control panel key switch to "Off" position.

IMPORTANT: Be sure to turn key "Off" for normal operation so that safety tilt switch on stern drive unit will function and engine will stop if drive unit strikes an underwater object.

POWER TRIM OPERATION
(Yellow-White-Green Buttons Panel)

NOTE: Remote control lever must be in "Neutral" or "Forward" position when operating Power Trim.

Power Trim is actuated by push button switches mounted in control panel.

TRIMMING BOAT

1. Trimming Out: Press green "Out" button (Figure 3) until drive unit moves to properly trim boat. Cutout switch will stop drive unit from moving out beyond gimbal ring flanges.
2. Trimming In: Press white "In" button (Figure 3) until drive unit moves to properly trim boat or until drive reaches end of downward travel.

TRAILERING BOAT

Raise drive unit for trailering or launching by placing remote control lever in "Neutral" or "Forward" and pressing yellow "Up" button on control. (Figure 3) Push trim "In" button to lower drive unit.

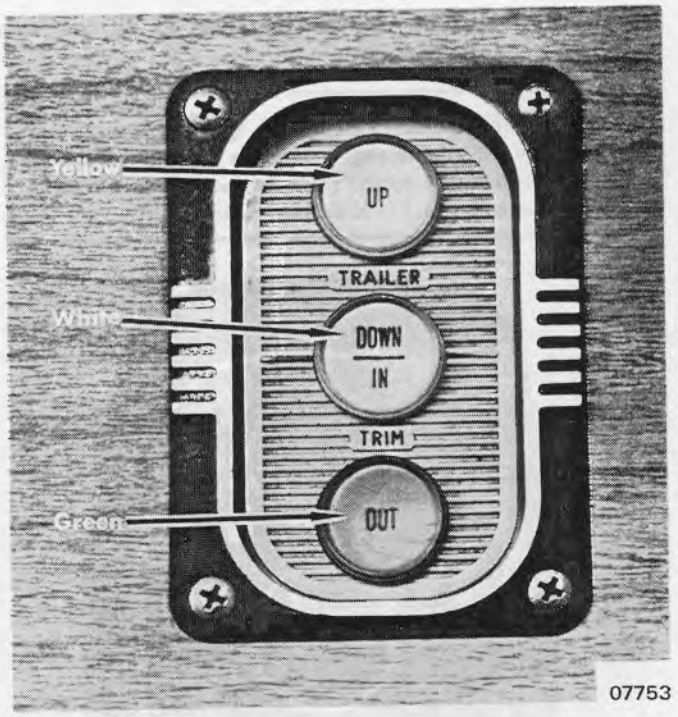

Figure 3. Yellow-White-Green Buttons Panel

POWER TRIM OPERATION
(Red-Red/Green-White Buttons Panel, Black Buttons Panel and Trim Switches Mounted in Remote Control)

CAUTION: When using Power Trim on some boats, operation at extreme "In" or "Out" positions greatly increases steering torque, and steering becomes difficult. Stern drive unit should be trimmed to a safe operating angle to provide easy steering.

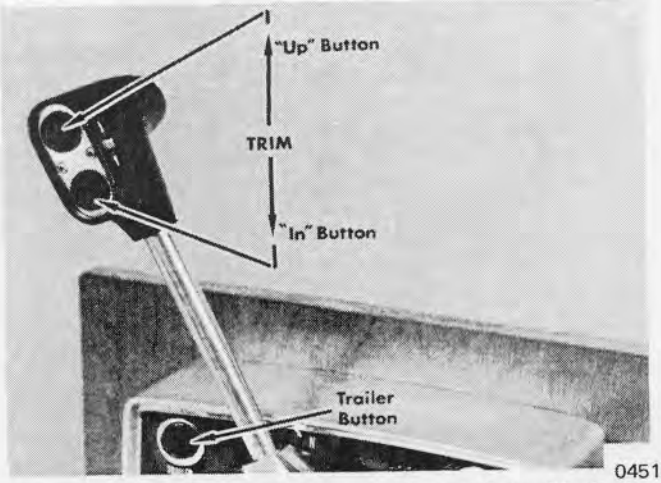

Figure 4. Push Button Switches in Control Lever MerCruiser 215-225II-TR and 255II-TR

NOTE: For initial installation and adjustment of trim sender and gauge, refer to the appropriate drive in Section 6.

Power Trim is actuated by push button switches mounted in control lever (Figure 4) or in trim control panel (Figure 5). Red-Red/Green-White button panel operates the same and is the same electrically as Black buttons panel shown in Figure 4.

Operate Power Trim only in neutral or forward gear.

TRIMMING BOAT

1. Trimming Out: Press "Up" button (Figure 4) until drive unit moves to properly trim boat. If control panel is used (Figure 5), press "Up/Out" button. Cutout switch will stop drive unit from moving out beyond gimbal ring flanges.
2. Trimming In: Press "In" button (Figure 4 or 5) until drive unit moves to properly trim boat or until drive reaches end of downward travel.

TRAILERING BOAT

1. Control Lever: Raise drive unit for trailering or launching by placing remote control lever in "Neutral" or "Forward" and pressing "Trailer" button on control. (Figure 4) Push

trim "In" button on lever to lower drive unit.

2. Control Panel: Raise drive unit for trailering or launching by shifting control to "Neutral" or "Forward" and pressing "Up" and "Up/Out" buttons simultaneously. (Figure 5) Push trim "In" button to lower drive unit.

Raise or lower drive with these buttons for shallow water operation at reduced throttle.

CAUTION: Do not run at high speed with drive unit out beyond gimbal ring flanges, as drive unit will have no side thrust support. Exercise caution when operating at extreme angles in shallow water.

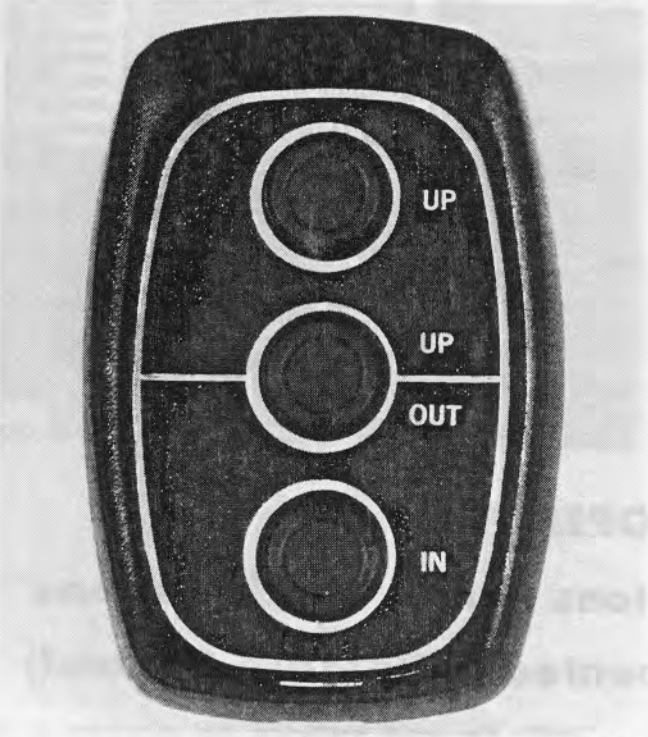

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Figure 5. Black Buttons Trim Control Panel

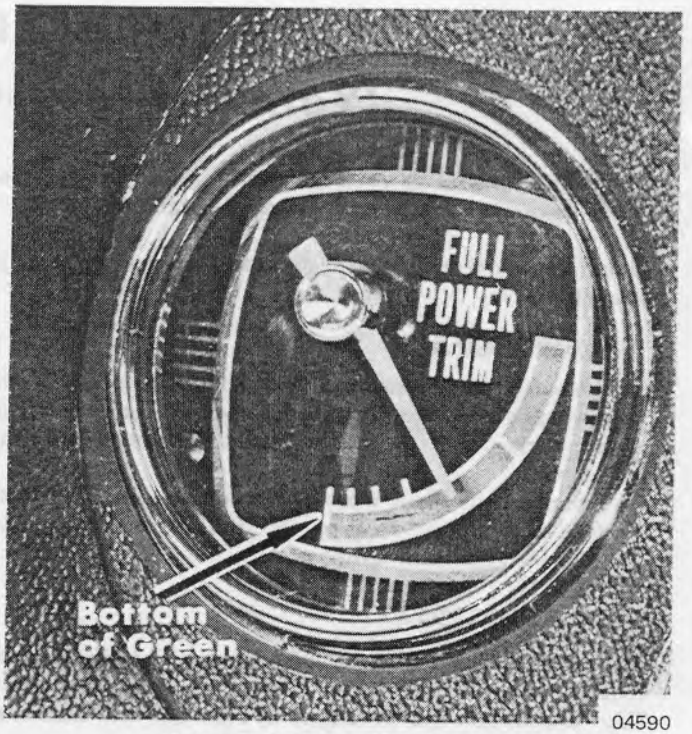

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Figure 6. Indicator Readjustment

NOTE: If button is held depressed after drive unit reaches end of upward travel, an overload cutout switch will open and pump motor will stop. To prevent cutout from opening, it is recommended that button(s) be released when drive unit reaches end of upward travel. If cutout should open, do not depress switches for approximately one minute. After this period of time, cutout will close and unit may be operated.

INDICATOR READJUSTMENT

If unit was fully extended into the "Up" trailer position, it may be necessary to reset the indicator by operating "In" button. Hold until indicator needle (Figure 6) reaches bottom of green arc.

PRE-IGNITION and DETONATION

PRE-IGNITION

Pre-ignition is abnormal fuel ignition, caused by combustion chamber hot spots. Control of the start of ignition is lost, as combustion pressure rises too early, causing power loss and rough running. The upward motion of the piston is opposed by the pressure rise. This can result in extensive damage to the internal parts from the high increase in combustion chamber temperature. (Figure 1)

PRE-IGNITION CAUSES

1. Hot spots in the combustion chamber from glowing deposits (due in turn to the use of improper oils and/or fuels).
2. Overheated spark plug electrodes (improper heat range or defective plug).
3. Any other protuberance in the combustion chamber, such as an overhanging piece of gasket, an improperly seated valve or any other inadequately cooled section of material which can serve as a source.

Figure 1. Pre-Ignition Damage

DETONATION

Detonation, commonly called "fuel knock", "spark knock" or "carbon knock", is abnormal combustion of the fuel which causes the fuel to explode violently. The explosion, in turn, causes overheating or damage to the spark plugs, pistons, valves and, in severe cases, results in pre-ignition. (Figure 2)

Use of low octane gasoline is one of the most common causes of detonation. Even with high octane gasoline, detonation could occur if engine maintenance is neglected.

OTHER CAUSES of DETONATION

WARNING: DO NOT operate MerCruiser inboard engines or stern drive engines with new "lead-free" or "no-lead" gasolines. Valve seat failure may occur from the use of these lead-free fuels. Regular leaded and low-lead fuels are satisfactory in all MerCruiser four-cycle engines.

1. Over-advanced ignition timing.
2. Lean fuel mixture at or near full throttle (could be caused by carburetor or leaking intake manifold).
3. Cross-firing spark plugs.
4. Excess accumulation of deposits on piston and/or combustion chamber (results in higher compression ratio).

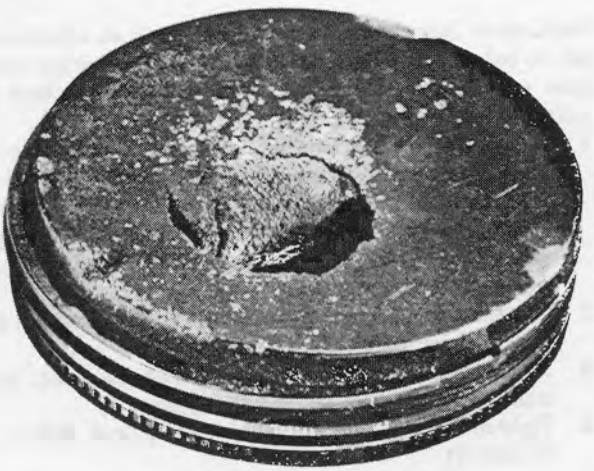

Figure 2. Detonation Damage

5. Inadequate cooling of engine by deterioration of cooling system.

Engine failures, which result from the foregoing conditions, are beyond the control of Mercury Marine, therefore, no warranty will apply to failures which occur under these conditions.

TRIM TAB
REMOVAL and REPLACEMENT

1. Before removing trim tab, mark trailing edge location on cavitation plate and remove plug which is located directly above trim tab. (Figure 3)
2. Loosen screw, which holds trim tab, thru hole in drive housing with a 5/16 or 3/8 allen wrench.
3. Clean recess area to assure metal-to-metal contact between drive and trim tab.
4. Place trim tab in position and secure by reversing removal steps.
5. Readjust trim tab, following, if necessary.

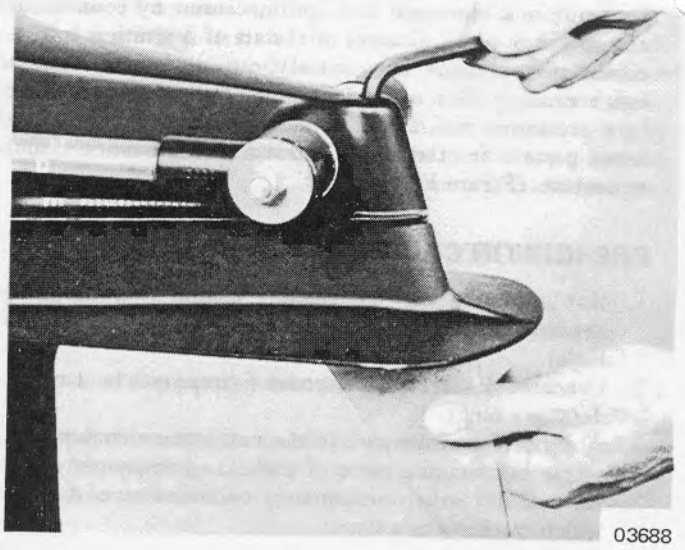

Figure 3. Removing Trim Tab

TRIM TAB ADJUSTMENT

MerCruiser Stern Drives are equipped with an adjustable trim tab to balance "steering torque" so that the steering wheel will turn with equal ease in each direction. Adjust trim tab as follows:

1. Operate boat at best throttle setting. Adjust tilt pin setting or trim boat as outlined under "Power Trim Operation", in this section. Turn steering wheel to left and right, noting in which direction wheel turns more easily. With boat at rest, remove plug from drive shaft housing and loosen allen head screw. (Figure 3)
2. If steering wheel turns more easily to left, position trailing edge of trim tab to left. (Figure 4)
3. If steering wheel turns more easily to right, position trailing edge of trim tab to right. (Figure 4)
4. Tighten socket head screw securely and replace plug. (Figure 3)
5. Operate boat to check setting. Readjust trim tab if necessary.

NOTE: When trimming-in or trimming-out, steering torque may increase even though trim tab has been adjusted properly. Trim tab will be the most effective at the boat speed and trim setting for which tab was adjusted.

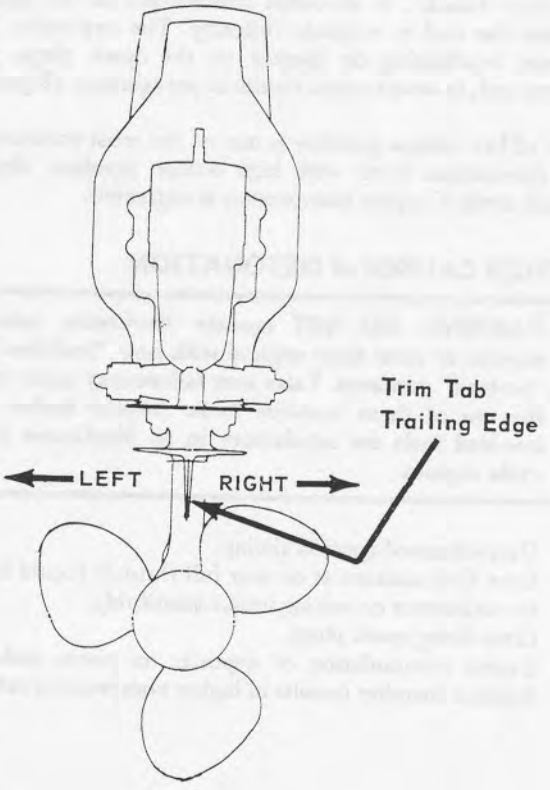

Figure 4. Trim Tab Trailing Edge

MERCRUISER FUEL SYSTEM

Observe Coast Guard Regulations when installing fuel system. The following suggestions also should be followed to ensure trouble-free service.

FUEL TANK - CAUTIONS

In many cases of engine malfunction with fiberglass fuel tanks, we have found wax (used in tank construction) dissolved by the fuel and lodged in the fuel filters. This condition is difficult to detect and, although the filters may appear to be in perfect condition, fuel flow is restricted and results in a lean-out condition that can be corrected only by replacing filter elements. In other types of fiberglass fuel tanks, minute particles of fiberglass remain in the tank after construction, with subsequent clogging of fuel filters.

In addition, the fuel pickup in "built-in" or special fuel tanks is unsuitable to handle fuel requirements to the engine, thereby causing engine malfunction.

CAUTION: Special or "built-in" fuel tanks are not approved. Exercise caution if used with MerCruiser engine.

Other causes of engine malfunctions are:

1. Fuel pickup has too small a screen or filter over end.
2. Poor joints or connections causing air leaks in fuel system.
3. Absence of large openings at reasonable location prevents proper fuel pickup installation.
4. Some types of galvanized tanks cause flaking of plating, thereby clogging fuel pickup and filters.
5. Tanks, which have been spray-painted on the inside, experience flaking which clogs pickup and filters.
6. Fuel tanks should be installed in a position below the carburetor itself when boat is at rest. If tank is located above carburetor, gravity feed could cause carburetor flooding.
7. Rocking or jostling of boat, while moored, may result in unseated inlet needle valve and cause carburetor to flood. This will allow raw fuel to enter intake manifold and combustion chambers and seep past piston rings, thus diluting crankcase oil. If this condition exists, it can be corrected only by relocating fuel tank so that fuel level in tank is below carburetor bowl when boat is at rest.

FUEL LINES - LENGTH and SIZES

1. If length of fuel line is less than 30 ft. (9.144m), use line and fittings which have an inside diameter of not less than ¼" (6.35mm). If length of fuel line is more than 30 ft., use line and fittings which have an inside diameter of not less than 5/16" (7.94mm).
2. Fuel line size must not be smaller than 5/16" ID on engines of 200 HP and over. A larger line should be used in cases where long lines, valves, manifolds and filters are used.
3. Use copper lines and flare type fittings.
4. Fuel line must be installed free of stress and firmly secured to prevent vibration and/or chafing.
5. Avoid sharp bends.
6. Flex line on inlet side of fuel pump must be connected to copper line to absorb any vibration or movement caused by motor mount deflection when engine is running.

ELECTRICAL INSTALLATION

1. Prior to reinstalling electrical connections for control and accessory harnesses, select proper schematic wiring diagram.
2. Neutral starting switch leads (yellow) from control box and instrument panel must be connected individually to prevent starting engine in gear. Connect both yellow leads from instrument panel together, if control is not equipped with a neutral starting switch.
3. Drive unit switch leads must be connected for tilt or trim system to function properly.
4. Connect leads per color code, as specified in wiring diagram.
5. Nut and screw connections should be coated with Liquid Neoprene (C-92-25771). A protective insulating sleeve also should be used to prevent possible short circuits.

SECTION 1 - GENERAL INFORMATION

MERCRUISER

PART B - TUNEUP

MERCURY MARINE

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TUNE-UP DESCRIPTION

This section outlines procedures to follow when performing engine tuneup on MerCruiser Marine Engines and Stern Drives. To assure lasting results, it is advisable that the service technician follow a definite and thorough procedure of analysis and correction of all items which affect power, performance and economy.

The extent of engine tuneup usually is determined by the interval since the last engine service. Servicing of specific items on the engine should be performed at regular intervals, depending upon operating conditions. When major corrective action is required, refer to appropriate sections of this manual for detail service information.

COMPRESSION TEST

1. Remove any foreign matter from around spark plugs by blowing away with compressed air, then remove plugs.

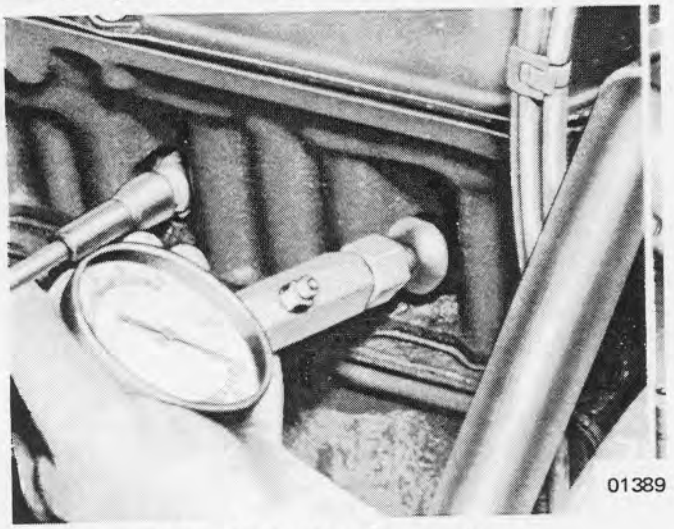

Figure 1. Checking Compression

2. Remove flame arrestor and block throttle and choke in wide open position.
3. Insert compression gauge firmly in spark plug port. (Figure 1)
4. Crank engine thru at least 4 compression strokes to obtain highest possible reading.
5. Check and record compression of each cylinder. Compression should read as indicated in tuneup "Specifications" Section 8. Variation between highest and lowest reading cylinders should be less than 20 lbs. ($1.4 kg/cm^2$).
6. If one or more cylinders read low or uneven, inject a tablespoon of engine oil on top of pistons thru spark plug port. Crank engine several times and recheck compression.
7. Checking results:
   a. If compression increases, but does not necessarily reach normal, rings are worn.
   b. If compression does not improve, valves are sticking or seating poorly.
   c. If 2 adjacent cylinders indicate low compression and injecting oil does not increase compression, the cause may be a head gasket leak between cylinders with resulting engine coolant and/or oil in cylinders.

SPARK PLUGS

CONVENTIONAL TYPE

1. Inspect each plug for broken, glazed or blistered procelain and badly worn electrodes. Replace plugs which are not serviceable. Be sure that all plugs are the same make and number as listed under specifications.
2. Prior to installing used plugs, file center electrode flat and adjust gap to setting with a round feeler gauge. (Figure 2)
3. Prior to installing new plugs, adjust gap to setting listed in specifications, with a round feeler gauge. (Figure 2)
4. Wipe plug seats in cylinder head clean. Place new gaskets on used plugs and thread plugs into cylinder head. Tighten plugs with a torque wrench to "Specifications" Section 8. If torque wrench is not available, turn plugs in finger-tight, then turn an additional ¾-turn with a wrench.

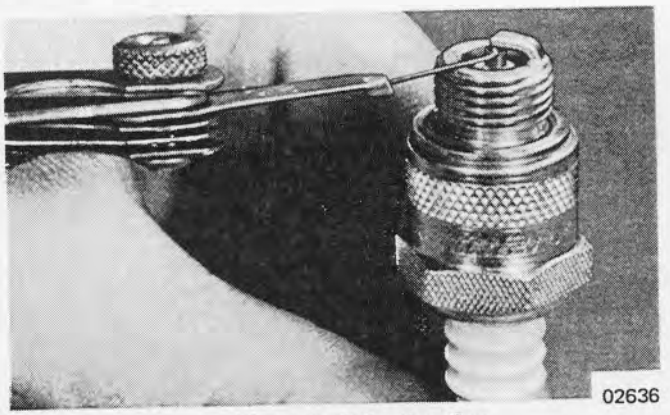

Figure 2. Adjusting Gap

POLAR GAP TYPE

1. Check condition of external insulator. If insulator is cracked, replace plug.
2. Check depth of center electrode as shown in Figure 3. If electrode is burned back more than 1/32" (.8mm), replace plug.
3. Cracks, which may be found around internal insulator (electrode end), will not harm plug operation, and plug may be used.
4. Wipe plug seats in cylinder head clean, place new gaskets on used plugs and thread plugs into cylinder head. Tighten plugs with a torque wrench to "Specifications" Section 8. If torque wrench is not available, turn plugs in finger-tight, then turn an additional ¾-turn with a wrench.

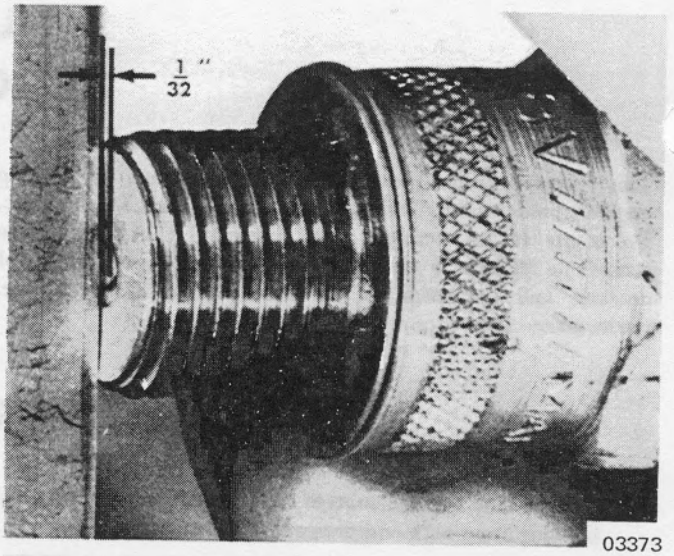

Figure 3. Checking Spark Plug Electrode Depth

IGNITION SYSTEM

1. Check spark plug leads and coil lead for abrasions or other damage. Replace leads which are not serviceable, being sure that leads are connected securely to the correct spark plugs.
2. Remove distributor cap, clean and inspect for cracks, carbon tracks and eroded electrodes. Replace cap if damage is found.
3. Check distributor centrifugal advance mechanism by turning rotor clockwise by hand as far as possible, then releasing rotor so that springs return it to its retarded position. If rotor does not return readily, distributor must be disassembled and cause for malfunction corrected.
4. Clean rotor and inspect for cracks and badly eroded electrode. Replace rotor if damage is found.

BREAKER POINTS and CONDENSER REPLACEMENT or CLEANING

NOTE: Does not apply to Thunderbolt Ignition.

1. Remove distributor cap and rotor.
2. Remove breaker points and condenser.
3. Examine distributor points and clean or replace if necessary. Contact points with an overall gray color and only slight roughness or pitting need not be replaced. Replace points which are burned or badly pitted. Replace condenser when replacing points, unless sufficient test equipment is available to check for a defect.
4. Dirty contacts should be cleaned with a clean ignition point file. Do not use emery cloth or sandpaper, since particles will imbed and cause arcing and rapid burning of points.

FINDING CAUSE OF TROUBLE: Where burned or badly pitted points are encountered, ignition system and engine should be checked to determine cause of trouble so that it can be eliminated. Unless condition, which causes point burning or pitting, is corrected, new points will provide no better service than the old points.

5. Clean distributor and breaker plate.
6. Place points and condenser in position and tighten hold-down screws.
7. Tighten all connections.
8. Lubricate distributor cam with a thin film of high-melting-point, non-bleeding grease or replace distributor cam shaft lubricating wick.

POINTS SPRING TENSION

1. Check distributor point spring tension (contact point pressure) with spring gauge, hooked to breaker lever at contact, and pull at 90° to breaker lever. Points should be closed (cam follower between lobes) and reading taken just as points separate for spring tension. Refer to "Specifications" Section 8.
2. If tension is not within limits, adjust by bending breaker lever spring. If pressure is excessive, if can be decreased by pinching spring carefully. To increase pressure, lever must be removed from distributor so that spring can be bent away from lever. Avoid excessive spring distortion! Do not bend with pliers.

NOTE: Excessive point pressure will cause excessive wear on points, cam and rubbing block, while weak point pressure permits bouncing or chattering which results in arcing and burning of points and an ignition miss at high speed.

POINT ALIGNMENT

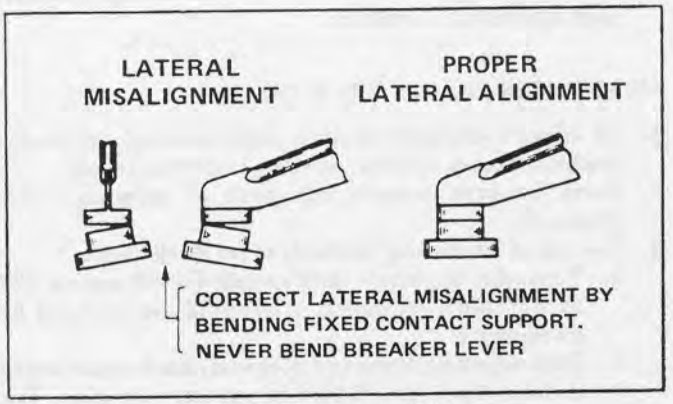

Figure 4. Alignment of Points

1. Check alignment of distributor points with points closed. (Figure 4) Align new points where necessary, but do not attempt to align used points. Instead, replace used points where serious misalignment is observed.
2. Align points by bending fixed contact support as necessary with alignment tool, if available. Do not bend breaker arm!
3. Inspect alignment of rubbing block with cam and check for a twisted arm or pivot pin if alignment is not correct. Correct contact point opening is important, particularly during starting and low speed operation. If contact points are set too close, arcing and burning will occur and cause hard starting and poor low speed performance. If points are set too wide, cam angle or dwell will be too small to allow saturation of coil at high engine speeds and result in a weak spark. Distributor point opening has a direct

bearing on cam angle or dwell, which is the number of degrees that breaker cam rotates from the time points close until they open again. (Figure 5)

NOTE: Breaker arm rubbing block must be positioned at a high point on cam when adjusting.

4. Adjust point gap or dwell (see following section).
5. Make sure that all distributor wire terminals are clean and tight.
6. Install rotor and distributor cap.

NOTE: Use notch or outer edge of distributor cap as a guide for proper replacement (over primary wire) of cap. It is possible to install incorrectly.

7. Press all wires firmly into cap towers.

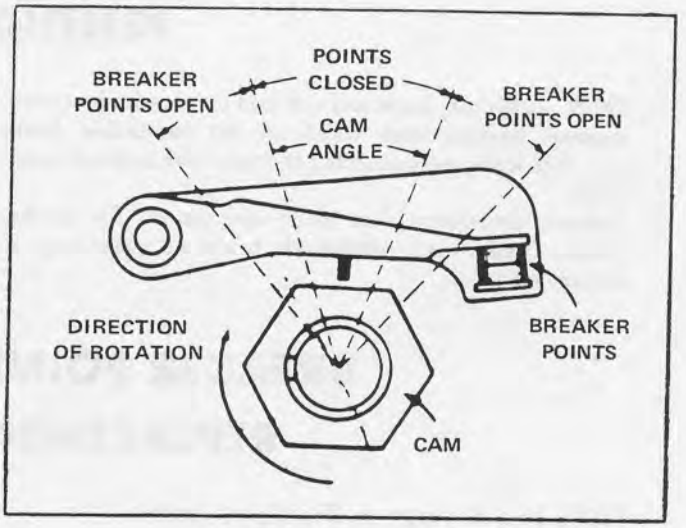

Figure 5. Cam Angle

POINT GAP and DWELL ADJUSTMENT

MERCRUISER 60, 80 and 90

NOTE: Clean used contact points before adjusting.

1. Loosen contact support lock screw and turn adjusting screw to obtain proper gap. See "Specifications" section.
2. Retighten contact support and lock screw.
3. After checking and adjusting contact point opening to specifications, cam angle or dwell may be checked with a contact angle meter, if such equipment is available. Refer to "Specifications" section for proper cam angle. If cam angle is less than specified minimum, check for defective cam lobes. Variation in cam angle readings between idle speed and 1750 engines RPM should not exceed 3°. Excessive variation in this speed range indicates wear in distributor.

MERCRUISER 120-140-160-165-200

Point gap or dwell can be adjusted by 2 methods. It is preferred that points be adjusted with a feeler gauge, then checked with a dwell meter, if available, with engine running. Points, however, also can be adjusted, as well as checked, with a dwell meter as follows:

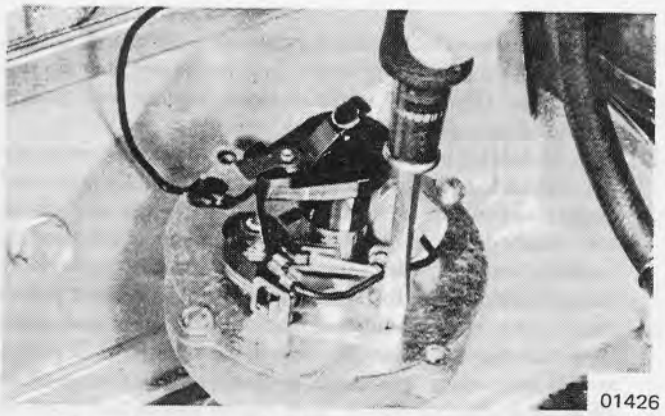

Figure 6. Adjusting Points on 4 and 6-Cylinder Models

1. Remove distributor cap.
2. Remove rotor and hook up dwell meter.
3. Loosen point lock screw slightly.
4. While cranking engine with starter, adjust dwell with a screwdriver (Figure 6) to obtain reading on dwell meter, as specified in "Specifications" Section 8, and tighten lock screw.

NOTE: Cam angle increases as point opening is decreased and vice versa.

5. Install rotor and distributor cap and recheck dwell with engine running.

MERCRUISER 888-215-225 II-TR and 255 II-TR

1. If necessary, align points by bending stationary bracket. DO NOT bend the breaker arm.
2. Rotate distributor until rubbing block rests on peak of cam lobe, which will provide maximum breaker point opening.
3. Insert correct feeler gauge between breaker points.
4. Loosen lockscrew and adjust points to correct gap.
5. After adjusting contact point opening to specifications, check cam angle or dwell with a contact angle meter, if such equipment is available.

MERCRUISER 225 (Not 225 II-TR)

1. To adjust dwell angle (contact point opening), run engine at idle and raiser window provided in distributor cap.
2. Insert hex-type wrench into head of adjusting screw. (Figure 7)
3. Use one of 2 following methods to set dwell angle:
   a. Turn adjusting screw until specified dwell angle of 28° to 32° (30° preferred) is obtained, as measured by dwell meter.
   b. Turn adjusting screw in (clockwise) until engine begins to miss, then turn ½-turn in opposite direction. This method is used only when dwell meter is not available.

4. Since contact point set is factory aligned on assembly, dwell angle is only necessary adjustment.

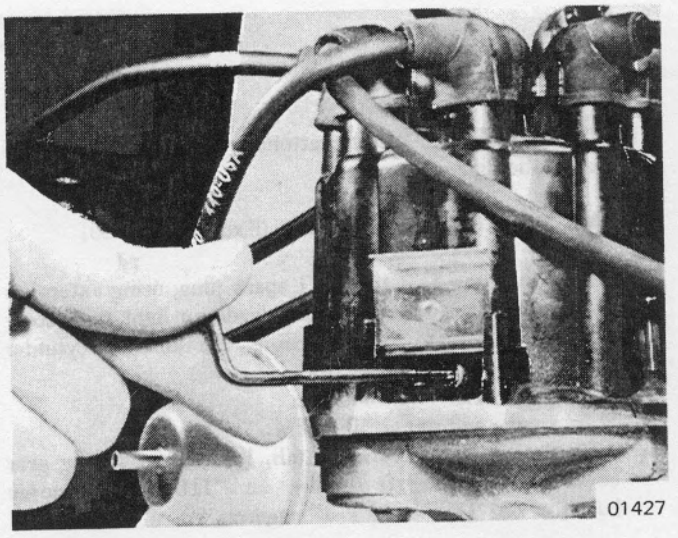

Figure 7. Setting Dwell Angle - MerCruiser 225

IGNITION TIMING

TIMING MARK LOCATION

The timing marks and their locations are illustrated in Figures 1-thru-7, following.

TIMING MERCRUISER ENGINES (Except 60-80-90)

1. Connect timing light to No. 1 spark plug, using extension at plug. Connect power supply leads on light to battery (12 volts). Refer to "Specifications" Section 8 for cylinder numbering and location.
2. Connect tachometer to engine.
3. Start engine and run at 500 RPM.
4. Aim timing light at timing tab, located on timing gear cover and crankshaft pulley on "110" or harmonic balancer on "140" and "V-8" engines.

NOTE: Early production "110" and "140" engines have timing tab located at right (starboard) side of timing gear cover and timing notch on outer edge of crankshaft pulley or harmonic balancer. (Figures 1 and 2)

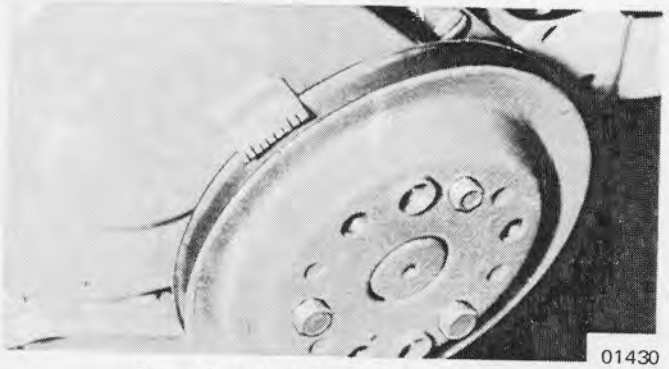

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Figure 1. Early Timing Tab on 110

Late production "110" and "140" engines have timing tab located on left (port) side of timing bear cover and timing notch on inner edge of crankshaft pulley or harmonic balancer. (Figure 3)

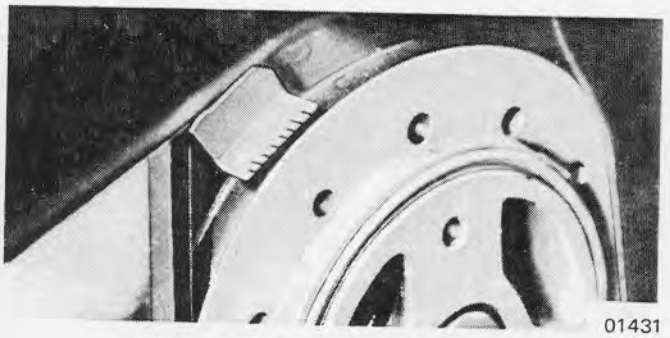

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Figure 2. Early Timing Tab on 140

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Figure 3. Late Timing Tab on 4 and 6-Cylinder

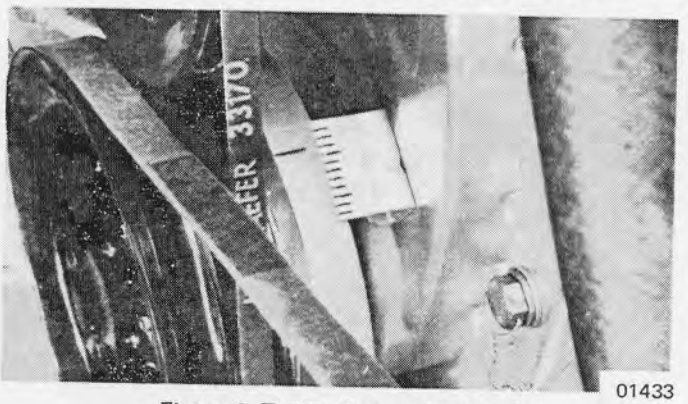

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Figure 4. Timing Tab on V-8 Engine

Markings on tabs are in 2° increments, with greatest number of markings on "A" side of "O". All BTDC settings fall on the "A" (Advance) side of "O".

5. Adjust timing by loosening distributor clamp and rotating distributor body as required until timing mark on balancer or pulley lines up with mark on tab specified in "Specifications" Section 8. Tighten clamp and recheck location of timing mark.
6. Stop engine and remove timing light.

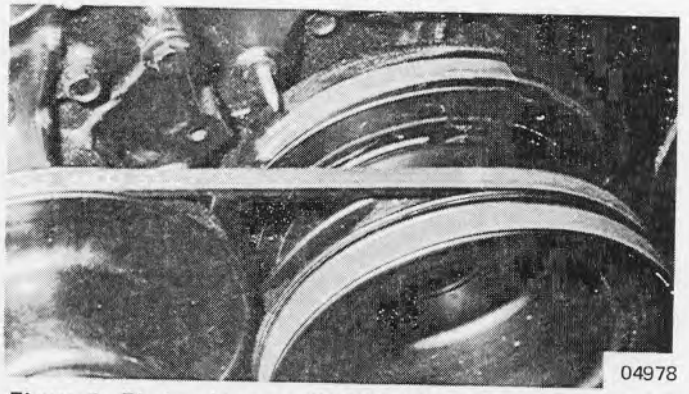

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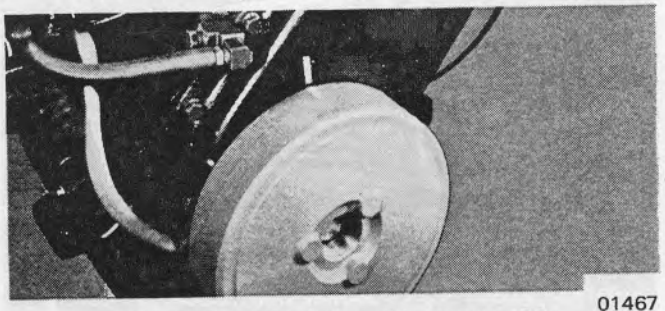
Figure 5. Timing Line on 888-215-225 II-TR and 255 II-TR Engines

TIMING MERCRUISER 60, 80 and 90

ENGINE NOT RUNNING

1. Locate No. 1 piston if firing position by either of 2 methods described below.
   a. Remove No. 1 spark plug and, with finger on plug hole, crank engine until compression is felt in No. 1 cylinder. Continue cranking until mark on timing chain cover lines up with timing mark on alternator flywheel or . . .
   b. Remove rocker cover and crank engine until No. 1 intake valve closes, then continue to crank slowly until mark on timing chain cover lines up with timing mark on alternator flywheel. (Figure 6)



01467

Figure 6. Timing Tab on MerCruiser 60

NOTE: No. 1 cylinder is cylinder nearest transom.

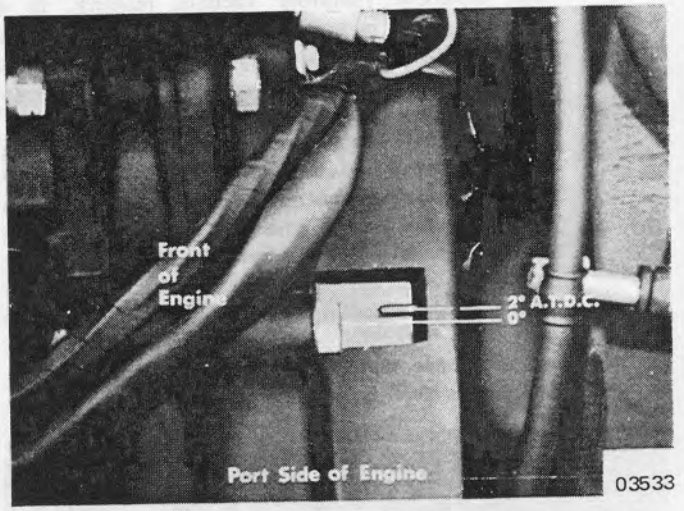
2. Connect 12-volt test lamp or voltmeter between distributor primary lead screw and to ground.
3. Turn on ignition switch.
4. Loosen distributor hold-down clamp and turn distributor counterclockwise until test lamp lights or voltmeter indicates 12 volts. This indicates that contact points and just opening.
5. Tighten distributor hold-down clamp.

ENGINE RUNNING

1. Connect timing light to No. 1 spark plug.

   NOTE: No. 1 cylinder is cylinder nearest transom. Refer to "Specifications" Section 8.

2. Connect power supply leads on timing light to battery.
3. Start engine and run at 650 RPM.
4. Aim timing light at timing mark on timing chain cover.
5. Loosen distributor hold-down clamp and turn distributor in either direction required until timing mark on alternator flywheel aligns with mark on housing. (Figure 7)
6. Tighten distributor hold-down clamp and recheck alignment of timing marks.
7. Stop engine and remove timing light.



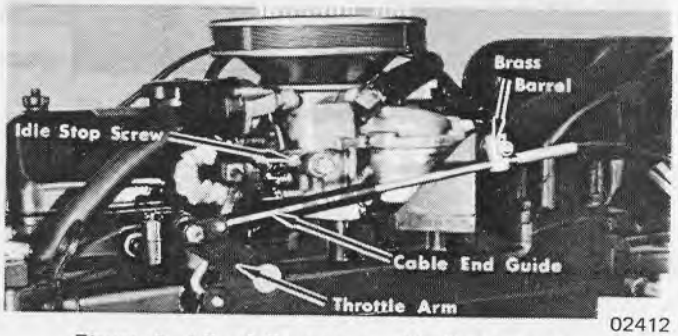
03533

Figure 7. Lining-Up Timing Marks - 80 and 90

CARBURETOR ADJUSTMENT

The following carburetor adjustments should be performed.

1. Clean or replace carburetor inlet fuel filter.
2. Idle mixture and speed adjustment - all models
   a. Be sure that flame arrestor is installed.
   b. Start engine and allow to run until normal operating temperature is reached and choke is fully open.
   c. Stop engine; disconnect throttle cable from engine.
   d. Start engine: Adjust idle speed screw to obtain recommended idle RPM as indicated in "Specifications" Section 8.
   e. Adjust idle mixture screw(s).
      1) Stop engine; turn idle mixture adjusting needles in until they very lightly just touch adjusting needle seat, then back needles off seats the specified number of turns for preliminary idle adjustment.
      2) Start engine. Adjust idle mixture needle for highest, steadiest manifold vacuum reading. If a vacuum gauge is not available, obtain smoothest running, maximum idle speed by turning idle adjusting needle in until engine RPM begins to drop off, then backing needle off over "high spot" until engine RPM again drops off. Set idle adjusting needle halfway between the 2 points for satisfactory idle mixture setting. Repeat procedure with other needle. Should these adjustments show an increase in idle RPM, reset idle speed adjusting screw to obtain specified idle RPM and again adjust idle mixture adjusting needle. (Figures 1-2-3-4-5-6 and 7)
3. Stop engine. Check that throttle valves are fully open when remote control is in full forward position. On



02412

Figure 1. Idle Adjustment - MerCruiser 80

(Some "80" Models Have Adjustments on Opposite Side)

MerCruiser 120-thru-165, with throttle valves fully open, turn wide open throttle stop adjusting screw clockwise until screw just touches throttle lever. (Figure 3) Tighten

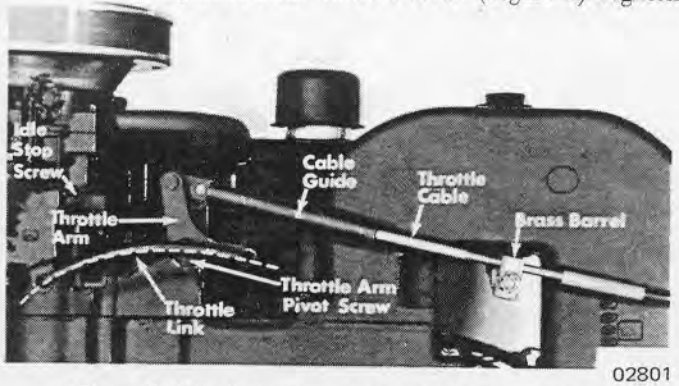


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Figure 2. Idle Adjustment - Early MerCruiser 120

set nut securely to prevent adjustment screw from turning. Return control to neutral gear, idle position, and check that idle stop screw is against stop.

IMPORTANT: Do not turn idle mixture screw(s) tightly against stop, or mixture needle and/or seat will be damaged.

   f. Shift unit into forward gear.
   g. Re-adjust idle speed screw to obtain recommended idle RPM.

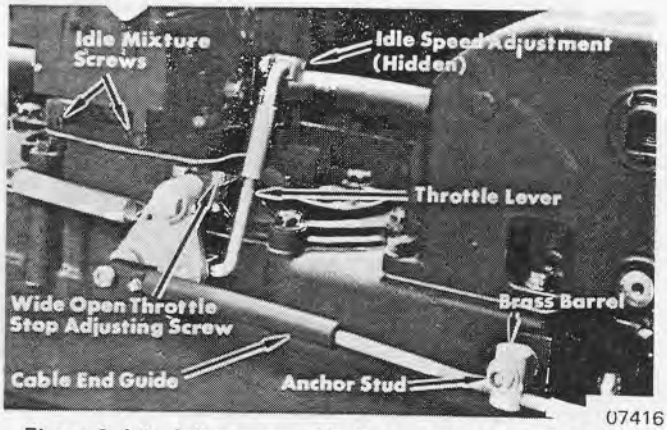

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Figure 3. Idle Adjustment - MerCruiser 120-140-160-165-200

(MerCruiser 200 Does Not Have WOT Stop Screw)

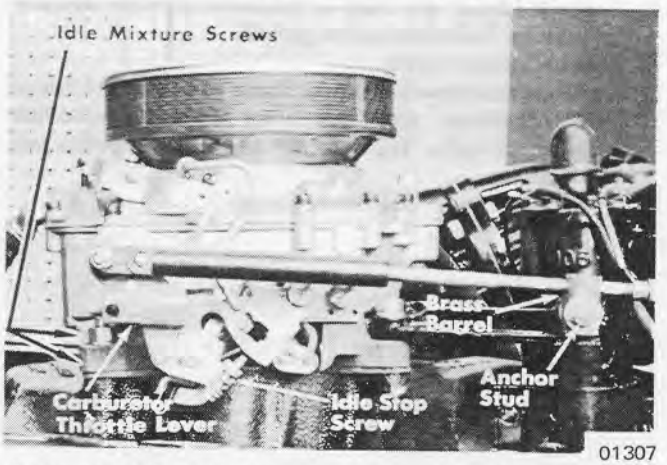

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Figure 4. Idle Adjustment - MerCruiser 225 (With 4GC Carburetor)

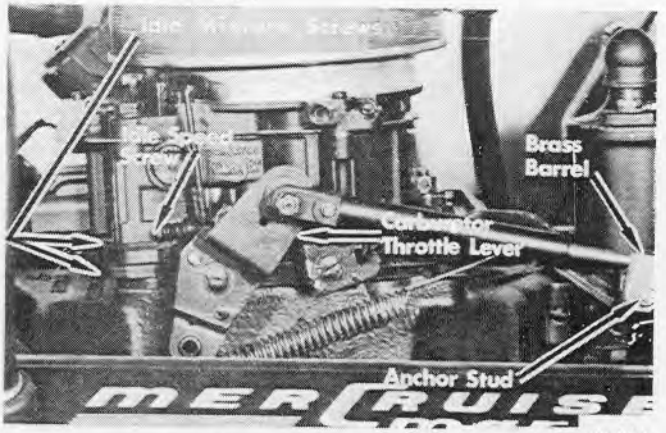

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Figure 5. Idle Adjustment - MerCruiser 225-250-325

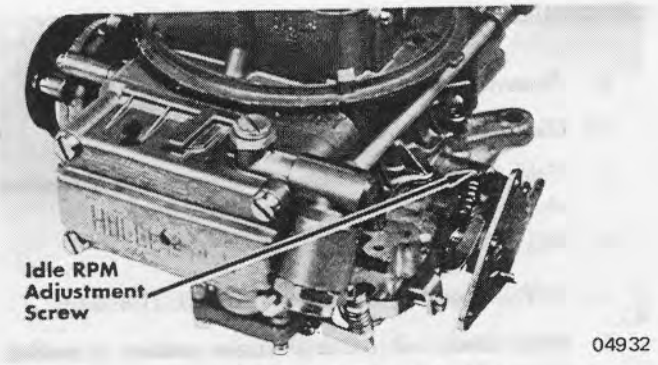

Figure 6. Idle Adjustment Screw -
MerCruiser 888-215-225 II-TR and 255 II-TR

Figure 7. Idle Mixture Screw -
MerCruiser 888-215-225 II-TR and 255 II-TR

h. Stop engine and move shift lever to neutral position.
i. Connect throttle cable (see throttle cable adjustment, following).

3. Automatic choke adjustment:

MERCRUISER 80-90-120-140-160-165;
MERCRUISER 215-888-225 II-TR and 255 II-TR with
HOLLEY MODEL; and 225 with 4GC CARBURETORS

a. Remove flame arrestor.
b. Check choke valve for binding or sticking.
c. Loosen 3 retaining screws.
d. Rotate choke cover against coil tension until index mark is lined up with proper index point.

PROPER INDEX POINT

(1) MerCruiser 80 set at last notch lean. (Figure 8)
(2) MerCruiser 90-120-140-160-165-888-215-225 II-TR and 255 II-TR-align choke plate mark with index point on housing. (Figure 9)
(3) MerCruiser 225 - set choke plate mark 3 notches lean of index point on housing. (Figure 9)

NOTE: Rotate clockwise for lean.

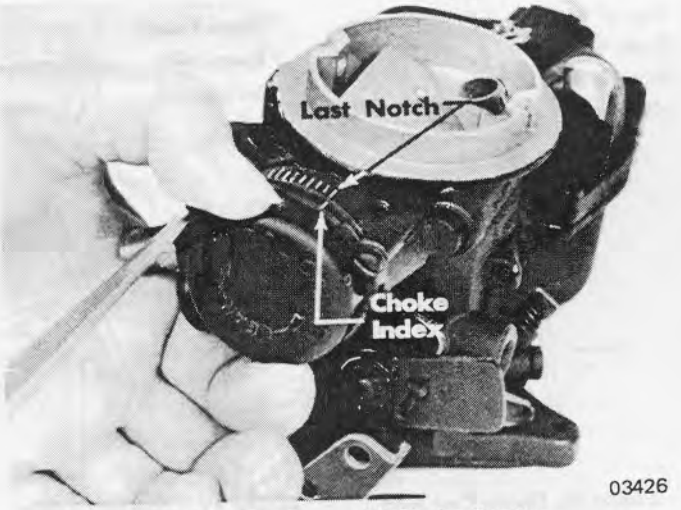

Figure 8. MerCruiser 80 Choke Setting

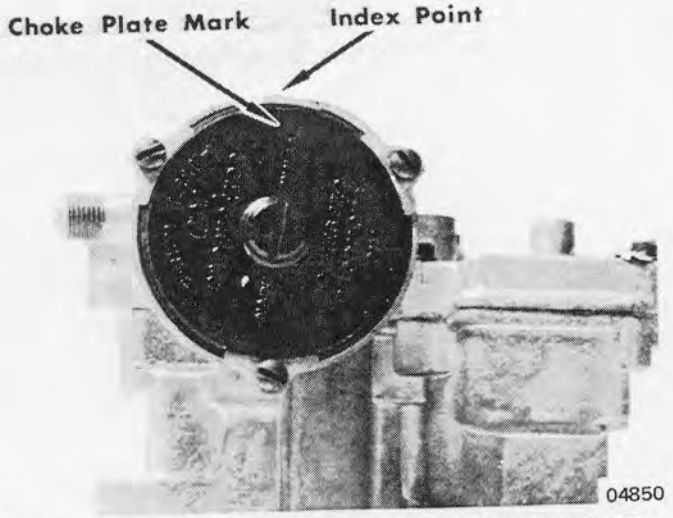

Figure 9. Typical Choke Setting - MerCruiser 90-120-140-160-165-888-215-225 II-TR and 255 II-TR

e. Before operation, choke should be lightly closed at room temperature.
f. At normal operating temperature, choke should move to full open.
g. After adjustment, tighten retaining screws and replace flame arrestor.

MERCRUISER 200-225-250
(With QUADRAJET CARBURETOR)

a. No adjustment is required on MerCruiser 200 or on carburetors with electric chokes.
b. MerCruiser 225-250
(1) Remove flame arrestor.
(2) Disconnect choke coil rod from choke lever.
(3) Hold choke valve shut in carburetor and position choke rod at bottom of choke lever hole.
(4) Push choke coil rod DOWN to end of travel.
(5) TOP of choke coil rod should be even with BOTTOM of hole in choke lever.
(6) Bend choke coil rod until above position is reached. (Figure 10)
(7) Connect choke coil rod and replace flame arrestor.

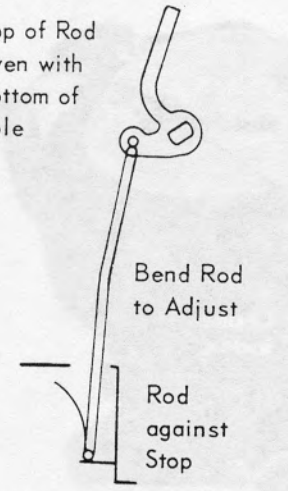

Figure 10. Choke Coil Rod Adjustment - 225-250 Engines

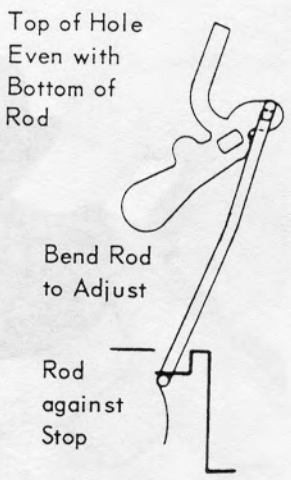

Figure 11. Choke Coil Rod Adjustment - 325 Engine

a. Remove flame arrestor.

b. Disconnect choke coil rod from choke lever.

c. Hold choke valve shut in carburetor and position choke coil rod at top of choke lever hole.

d. Pull choke coil rod UP to end of travel.

e. TOP of hole should be even with BOTTOM of rod.

f. Bend choke coil rod until above position is reached. (Figure 11)

g. Connect choke coil rod and replace flame arrestor.

4. Check float bowls for presence of water and corrosion.

THROTTLE CABLE ADJUSTMENTS

1. Place remote control handle in neutral gear, idle position. If boat is equipped with a single-lever MerControl with neutral warm-up lever, place lever in down position.
2. Fasten cable to throttle lever. See appropriate Figure in Removal, Installation and Alignment Section 2 under "Throttle Cable Attachment".
3. Fully contact throttle cable by grasping behind brass barrel and pushing toward throttle lever.
4. Adjust brass barrel to align with anchor stud.

NOTE: MerCruiser 120 Only - Position throttle arm so that centerline of link rod is over center of throttle arm pivot screw head prior to adjusting brass barrel.

5. Fasten brass barrel on stud with washers and elastic stop nuts.
6. Check that primary throttle valves are fully open when remote control handle is all-the-way forward.
7. Return control handle to neutral and check that carburetor throttle lever is against idle stop screw.

FUEL PUMP PRESSURE TEST

1. Disconnect fuel line at fuel filter and attach fuel pump pressure gauge to fuel line.
2. Start engine and run at idle. Observe reading on gauge. Pressure should be as specified in "Specifications" Section 8 and remain constant at all speeds between idle and 1000 RPM.
3. If pressure is too low, inspect fuel lines for kinks, leaks and restrictions and correct any defects found. If necessary, remove fuel lines and blow out with compressed air to remove any foreign material. When reinstalling lines, be sure that they are not twisted or kinked, thereby causing restriction. If pressure is too low or too high or varies at different speeds, pump should be removed for repair or replacement.
4. Remove gauge and reconnect fuel line to filter.

BATTERY and BATTERY CABLES

1. Inspect battery and cables and perform necessary service on these components.
2. Inspect for signs of corrosion on battery, cables and surrounding area, loose or broken carriers, cracked or bulged cases, dirt and acid, electrolyte leakage and low electrolyte level.
3. Fill cells to proper level with water.
4. Top of battery should be clean and battery fastened securely in position.
5. For best results, when cleaning batteries, wash first with a dilute ammonia or soda solution to neutralize any acid present, then flush off with clean water.
5. Keep vent plugs tight so that neutralizing solution does not enter cell.
7. Hold-down device should be kept tight enough to prevent battery from shaking around in its holder, but it should not be tightened to point where battery case will be placed under a severe strain.
8. To insure good contact, battery cables should be tight on battery posts. If battery posts or cable terminals are corroded, cables should be cleaned separately with a soda solution and wire brush. After cleaning and before installing clamps, apply a thin coating of Multipurpose Lubricant (C-92-49588) to posts and cable clamps to help retard corrosion.
9. If battery has remained under-charged, check for loose alternator drive belt, faulty alternator or voltage regulator.
10. If battery has been using too much water, voltage regulator setting may be too high, and regulator should be replaced if setting is too high.

VALVE ADJUSTMENT

MERCRUISER 60-80-90

NOTE: Following procedure, performed with engine at normal operating temperature, should be completed ONLY if readjustment is required.

1. After engine has reached normal operating temperature, remove valve cover.
2. With engine running at idle, back off valve rocker arm nut until valve rocker arm starts to clatter.
3. Insert feeler gauge between rocker arm and valve stem. (int. .008, exh. .010)
4. Turn rocker arm nut down until light drag is felt on feeler gauge. This is correct valve lash.

NOTE: Care must be taken to distinguish between intake valves and exhaust valves, as each requires different clearance.

5. Repeat Steps 2, 3 and 4 to adjust rest of valves.
6. Install valve cover and new gasket if necessary.

MERCRUISER 4, 6 and 8-CYLINDER HYDRAULIC LIFTERS

NOTE: Following procedure, performed with engine running, should be performed ONLY if readjustment is required.

1. After engine has reached normal operating temperature, remove valve cover and install a new valve cover gasket on cylinder head to help prevent oil from running out.
2. With engine running at idle, back off valve rocker arm nut until valve rocker arm starts to clatter.
3. Turn rocker arm nut down slowly until clatter just stops. This is zero lash position.
4. Turn nut down ¼ additional turn and pause until engine runs smoothly. Repeat additional ¼ turns, pausing each time, until nut has been turned down ¾-turn from zero lash position.

NOTE: This ¾-turn preload adjustment must be done slowly to allow lifter to adjust itself to prevent possibility of interference between inlet valve head and top of piston, which might result in internal damage and/or bent push rods. Noisy lifters should be replaced.

5. Repeat Steps 2, 3 and 4, above, to adjust rest of valves.
6. Install valve cover(s) with new gasket(s), if necessary.

MERCRUISER 888, 215, 225 and 255

No adjustment required. See "Engine Mechanical" Section 5.

MECHANICAL LIFTERS

MERCRUISER 8-CYLINDER

Following procedure is performed with engine at normal operating temperature.

1. After engine has reached normal operating temperature, remove valve cover and install valve cover with cut-out top to prevent oil from running out.
2. With engine running at idle, back off valve rocker arm nut until valve rocker arm starts to clatter.
3. Insert feeler gauge of correct thickness ("Specifications" Section 8) between rocker arm and valve stem.
4. Turn rocker arm nut down until light drag is felt on feeler gauge. This is correct valve lash.

NOTE: Care must be taken to distinguish between intake valves and exhaust valves, as each requires different clearance.

5. Repeat Steps 2, 3 and 4 to adjust rest of valves.
6. Install valve cover(s) and new gasket(s).
7. Adjust carburetor.

MANIFOLD

1. Inspect manifold for air, fuel and water leaks.
2. Tighten all cap screws and nuts. A slight air leak in intake manifold can drastically reduce engine performance.

CRANKCASE VENTILATION

1. Remove hose(s) which runs from fitting on rocker arm cover to carburetor(s).
2. Clean hose(s) and fittings if necessary.

SECTION 1 - GENERAL INFORMATION

MERCRUISER

PART C - LUBRICATION

MERCURY MARINE

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MERCRUISER LUBRICANT and MAINTENANCE CHART

Locations	After 1st 20 Hrs. of Operation	Every 50 Hours of Operation	Every 100 Hours of Operation	Once Each Year
Starter Motor and Alternator	None Required			
Change Engine Oil	1		1	
Replace Oil Filter	•		•	
Clean Oil Filler Cap			•	
Clean Flame Arrestor	•		•	
Change Fuel Filters				•
Change Auxiliary Fuel Filter Element				•
Check Fuel System Lines and Connections for Leaks	•	•		
Check Battery Electrolyte Level	•	•		
Check All Electrical Connections	•			•
Check Water Pump and Alternator Belts for Tension	•	•		
Check Cooling System Hoses and Connections for Leaks	•		•	
Check Power Steering Fluid Level		3		
Check for Loose, Damaged or Missing Parts		•		•
Lubricate Throttle and Shift Linkage Pivot Points				1
Lubricate Breaker Lever Pivot*				1
Lubricate Distributor Cam*				8
Inspect Breaker Points*			•	
Check Condition of Spark Plugs*				•
Tighten Engine Mount, Drive and Trim Cylinder Fasteners	•		•	
Check Engine Alignment	•			•
Check Transmission Fluid Level	3	3		
Clean Transmission Oil Strainer Screen				•
Check Condition of Oil Cooler Electrodes+	Every 6 Months			
Change Transmission Fluid				3
Check Power Tilt Pump Fluid Level	§		§	
Check Power Trim Pump Oil Level	1		1	
Check Stern Drive Oil Level	4	4		
Check Hydraulic Shift Unit Fluid Level	5	5		
Lubricate Drive Unit Upper and Lower Swivel Pins and Hinge Pins+	6		6	
Lubricate Steering Cable and Steering Lever Housing+	6		6	
Change Stern Drive Unit Oil				4
Check Condition of Trim Tab and Anodic Plate+	Every 30 Days			
Inspect Propeller for Possible Damage		•		•
Lubricate Propeller Shaft Splines+				7
Inspect Bellows+	•			•
Inspect and Clean Exterior+				•
Lubricate U-Joint Coupling Splines	•			•
Lubricate Gimbal Bearing			6	6
Lubricate U-Joint Cross Bearings			9	9
Check Stern Drive Unit Water Pump and Impeller				•

1 - **Use Formula 4 Quicksilver Oil (C-92-33157).**
2 - **Use Quicksilver Anti-Corrosion Grease (C-92-45134).**
3 - **Use Automatic Transmission Fluid (Type "A", Suffix "A").**
4 - **Use Quicksilver SUPER-DUTY Lubricant (C-92-52650).**
5 - **Use Non-Mineral Hydraulic Fluid SAE 70R1 or 70R3 (Brake Fluid).**
6 - **Use Multipurpose Lubricant (C-92-49588).**
7 - **Use Perfect Seal No. 4 (C-92-34227-1).**
8 - **Use suitable high-melting-point, non-bleeding grease.**
9 - **Use Universal Joint Lubricant (C-92-58229-1).**

* *Does not apply to "Thunderbolt Ignition".*

\+ *If unit is operated in salt water, require more frequent attention.*

§ *Refer to "3", above, for white high pressure pump; to "1" for black large reservoir pump; or use SAE 20W M.S. motor oil in white low pressure pump with booster valve.*

NOTE: Complete list of maintenance is not applicable to all models. The chart, above, is based on average operating conditions. Under severe operating conditions, continuous heavy duty or high speed operation, the inspection and maintenance intervals should be shortened.

STERN DRIVE LUBRICANT CAPACITIES

Model	Capacity
MerCruiser "60"	18.3 Fl. Oz.
MerCruiser "80"-"90"	22 Fl. Oz.
MerCruiser "I" Drive Shaft Housing	8 Fl. Oz.
MerCruiser "I" Gear Housing	18 Fl. Oz.
MerCruiser "IA-IB-IC" Drive Shaft Housing	8 Fl. Oz.
MerCruiser "IA-IB-IC" Gear Housing	23 Fl. Oz.
MerCruiser "120"-"140"-"160"-"165"-"888"	28 Fl. Oz.
MerCruiser "II"-"200"-"225"	5¾ Qts.*
MerCruiser "II" with Heavy-Duty Gear Housing	7 Qts.*
MerCruiser "III"-"250"-"270"-"325"-"390"	4½ Qts.+*
MerCruiser "215H"-"215E"-"225II-TR"-"255II-TR"	4 Qts.+*

* *Approximately* + *Stern Drive Capacity Plus Reservoir*

Metric Conversion: 1 Fl. Oz. = .03 Liter
1 Qt. = .946 Liter

NOTE: After filling a stern drive unit, that had been drained of all lubricant, the lubricant level must be rechecked after a "run-in" period of about one minute. This procedure assures that any air pockets, which may have developed during filling, will be eliminated. Additional lubricant may have to be added after rechecking to "top-off" the unit.

QUICKSILVER ENGINE CLEANER

Quicksilver Engine Cleaner (C-92-47949-12) is a laboratory and field-tested blend of chemicals designed to purge power-robbing deposits that accumulate in gasoline engines. It eliminates costly dismounting of the engine to remove carbon deposits caused by certain types of gasolines.

Heavy carbon deposits in combustion chambers result in spark plug burning, pre-ignition and reduction of RPM.

Quicksilver Engine Cleaner is effective in removing gum, varnish and carbon from the following:

- Outboards
- Inboards
- Snowmobiles
- Chainsaws
- Power Lawn Mowers
- Garden Tractors
- Other 2 and 4-Cycle Engines

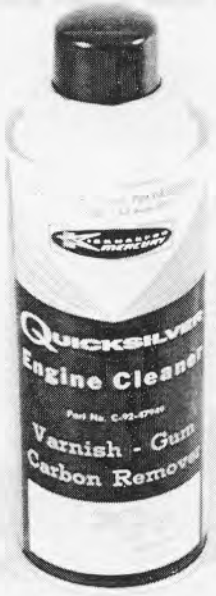

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Figure 1. Quicksilver Engine Cleaner (C-92-47949)

HOW TO USE

Run engine to normal operating temperature. Quicksilver Engine Cleaner is most effective when engine is warm. While operating engine at lowest RPM above stalling, spray a sufficient quantity of Engine Cleaner into throat of one carburetor. Allow engine to run until it is again firing on all cylinders and repeat process for other sets of carburetors. Next, flood entire engine thru carburetor(s) and allow to stand for ½-hour.

SEVERELY CARBONED ENGINES

Tilt engine in horizontal position and close as many intake and exhaust ports as possible by turning flywheel so that pistons cover ports. Spray Engine Cleaner thru spark plug holes. Allow engine to set for not more than a 6-to-8 hour period. After setting, place vertically and pull starter over several times to remove excess accumulation. Ready engine to run and repeat the regular cleaning process, as explained under "How to Use", preceding.

ADDITIONAL CLEANING BENEFITS

Mix one can of Quicksilver Engine Cleaner to one (1) gallon of fuel mixture. Run this special mixture until depleted, then follow normal application as outlined under "How to Use", preceding.

OTHER SUGGESTED USES

PENETRATING OIL

Quicksilver Engine Cleaner has a tremendous penetrating and soaking action. Frees engines which are tight from rust and corrosion caused by submersion.

PROTECTION for SUBMERGED ENGINES

Emulsifies with water and gives protective coat to parts. Remove water from engine and spray Engine Cleaner thru spark plug holes. Turn engine over several times, allowing it to drain into crankcase.

EXTERNAL CLEANER

Cleans and removes external marine growth, grease, oil and dirt deposits from engines. Spray on and allow to set for ½-hour.

WINTERIZING

It is good policy to clean the combustion chamber of engines with Quicksilver Engine Cleaner at time of winterizing, tuneup or (if engine has been in dealer storage) before delivery in spring. Apply Quicksilver Storage Seal (C-92-28143) for winterizing (after cleaning combustion chamber).

06491

Figure 2. Quicksilver Storage Seal (C-92-28143)

LUBRICANT GUNS

Where Quicksilver Multipurpose Lubricant (C-92-49588) is to be dispensed, the Pistoluber Grease Gun (C-91-37299) and Lube Gun (C-91-30500) speed the job.

Squeeze-grip design of Pistoluber Gun permits one-hand operation. High pressure 12" (30cm) flexible hose attaches easily to grease fittings on outboards and stern drives. Multipurpose tube screws directly on lightweight gun to prevent possible contamination of lubricant.

Lube Gun facilitates application on all linkage and exterior moving surfaces on outboards, stern drives, power mowers, chain saw parts and industrial units, where all-purpose lube is specified by the manufacturer, and on boat trailer wheel bearings. Also for application on Ride-Guide cables, shafts and other moving parts of marine accessories which require external lubrication.

OTHER MARINE LUBRICANTS

STORAGE SEAL

Protects interior metal surfaces during extended storage periods. Quicksilver Storage Seal (C-92-28143) is applied thru carburetor and spark plug openings.

MARINE CLEANER

Removes dirt, grease and scum from all boat and motor surfaces, as well as from power mowers, automobile engines, and grease-marked walls, floors and shop equipment. Quicksilver Marine Cleaner (C-92-32182) is non-flammable and leaves no odor nor insoluble residue.

CORROSION and RUST PREVENTIVE

Protects exterior metal surfaces from corrosion and rust during use and in storage. Quicksilver Corrosion and Rust Preventive (C-92-29152) also is handy to have around home workshops.

ENGINE LUBRICATION
OIL SELECTION

Crankcase oil should be selected to give the best performance under the climatic and operating conditions prevalent in the area in which the engine is operated. An oil, which will provide adequate lubrication under high operating tmperatures, is required during warm or hot weather. An oil, which will permit easy starting at the lowest atmospheric temperature likely to be encountered, should be used during the colder months.

When crankcase is drained and refilled, crankcase oil should be selected, not on basis of existing temperature at time of change, but on lowest temperature anticipated for period during which oil is to be used.

We recommend Mercury Marine 4-CYCLE MARINE MOTOR OIL FORMULA 4R. If not available, use any good grade automotive oil of correct viscosity which has an A.P.I. classification of "MS" or "SD".

The following chart shows the recommended viscosity for various temperature ranges and also the intervals at which the oil should be changed.

If the lowest anticipated temperature, during the interval in which the oil will remain in the crankcase, is	. . . the following Viscosity Oils are recommended.	When to Change Crankcase Oil *A. P. I. Classification "MS" or "SD"		
		Prevailing Daytime Temperature	Initial Oil Change Interval	Regular Oil Change Interval
90°F (32°C)	SAE 40*	Above 90°F (32°C)	1st 60 days or 20 hours of operation whichever occurs 1 st	Every 100 hrs of operation and at end of boating season.
32°F (0°C)	SAE 30*	Above 32°F (0°C)	1st 60 days or 20 hours of operation, whichever occurs 1st	Every 100 hrs of operation and at end of boating season.
0°F (-18°C)	SAE 20W*	Below 32°F (0°C) or during adverse operating conditions	First 30 days or 20 hours of operation, whichever occurs first.	Every 100 hrs of operation and at end of boating season.

DRAINING ENGINE OIL

1. Operate engine until normal temperature is indicated. If the crankcase is drained when the engine is cold, some of the suspended foreign material clings to the sides of the oil pan and will not drain out readily.
2. Remove dipstick and pump oil out of crankcase via dipstick tube.

   NOTE: An oil drain pump (C-91-34429) is available.

FILLING ENGINE CRANKCASE

NOTE: For engine crankcase capacity, refer to "Specifications" Section 8.

Because of the effect the installed angle of engine has on oil level, the following procedure must be followed and boat must be at rest in water.

IMPORTANT: SAE 20W, "MS" or "SD" 4-cycle motor oil, plus one pint (.47 liter) Quicksilver 4-Cycle Engine Oil Supplement (C-92-33365-1), must be used as initial oil fill. Engine oil supplement is a break-in additive which is required during break-in period. A can of this additive is shipped with each new engine. Be sure that it is added to initial oil fill.

1. Pour oil into engine thru oil fill opening in rocker arm cover until level comes up to full mark on dipstick.
2. Start engine and run at idle speed for 5 minutes.
3. Stop engine and, after approximately 5 minutes, check level on dipstick.
4. Add quantity of oil required to bring level up to full mark.

MAINTAINING OIL LEVEL

Check oil level frequently and add oil when necessary. Since modern engines are equipped with hard, chrome-face piston rings, which exert a low pressure between rings and cylinder walls, it takes more time to "seat" the rings. Initially, this may result in some oil consumption, but it will be more than offset by a noticeable reduced rate of engine wear. This is the major reason that most current model engines can run for so many hours before re-ringing. In the past, new rings were required in engines with few hours on the engine.

Every internal combustion engine should use a certain amount of oil to act as a lubricating and cooling agent during the break-in period. The initial rate of consumption will decrease until it becomes stabilized after about 100 hours operation.
When checking oil level, 1) the engine should be warm, 2) the boat must be at rest in the water, 3) the dipstick pushed down to the stop, and 4) five minutes must be allowed for oil to drain back into the pan. A false reading may be obtained if these steps are not followed.

The space between the "Full" and "Add" marks represent one quart. Add oil if the level is at or below the "Add" mark.

A proper oil level is an important factor in controlling oil consumption. An over-full crankcase allows oil to be splashed onto the cylinder walls by the reciprocating parts in greater quantities than the rings can control. The excess oil will be drawn into the combustion chamber and burned.

When an engine is used principally at slow speed conditions, considerable crankcase dilution occurs. A rapid lowering of the oil level may result when the boat is operated for some distance at high speed. The heat of high speed operation removes the dilution, which is a normal condition that should not be mistaken for excessive oil consumption.

OIL CONSUMPTION - 4 CYCLE ENGINES

Every 4-cycle, internal combustion engine should use a certain amount of oil to act as a lubricating and cooling agent, particularly during break-in period. The initial rate of consumption gradually will decrease until it becomes stabilized after approximately 100 hours operation. A 4-cylinder engine can consume one quart of oil in 5 to 14 hours of wide-open throttle operation. Higher engine operating temperature in automotive engine cause even higher oil consumption.

A break-in additive (Engine Oil Supplement, C-92-33365-1) is added to the initial fill of oil. Leave this oil in the engine for the recommended 20 hours or 60 days, whichever comes first. After the initial fill of oil has been drained, refill with Quicksilver Formula 4 or 4R oil, according to the oil specifications.

Modern engines are equipped with hard, chrome-face piston rings, which exert a low pressure between ring and cylinder wall, and take more time to "seat". This may result in some oil consumption, but it will be more than offset by a noticeable reduced rate of engine wear.

This is the reason that current model engines run for many hours before re-ringing is necessary.

Proper oil level is important in controlling oil consumption. An over-full crankcase allows oil to be splashed by the reciprocating parts onto cylinder walls in greater quantities than the rings can control. Excess oil will be drawn into the combustion chamber and burned. In extreme cases, oil may become aerated, causing it to foam and be discharged from the filler neck.

DO NOT over-fill the space between "Full" and "Add" marks (represents one quart). It is not necessary to add oil, unless level is at or below "Add" mark. When checking oil levels, engine should be warm and level. Allow about 5 minutes for oil to drain back from upper engine cavities. The dipstick must be pushed down to the stop.

When an engine is used principally at slow speed conditions, considerable crankcase dilution occurs. A rapid lowering of the oil level may result when engine is operated for some distance at high speed. This is a normal condition caused by heat of high speed operation and should not be mistaken for excessive oil consumption. If it is possible to determine that oil usage is caused by a mechanical malfunction, inspect for leaks. Check rocker cover, oil pan and side cover gaskets and crankshaft seals. Also check that neither valve guides nor stems are worn excessively, nor that valve stem seals are mispositioned or damaged.

OIL FILTER

A full-flow oil filter filters all of the oil delivered by the oil pump and, for this reason, interval of cartridge change is very important. Oil filter cartridge should be replaced after the first 20 hours and every 100 hours thereafter and at end of boating season.

1. Remove filter from cylinder block.
2. Coat sealing ring on new filter with engine oil and thread filter on block. Hand-tighten securely.
3. Fill crankcase as outlined under "Filling Engine Crankcase".
4. Check for oil leaks while engine is running.

COMPONENTS

ALTERNATOR

Under normal operating conditions, alternator will not require lubrication.
Refer to "Electrical System" Section 3, Part C - "Alternator" for bearing replacement and lubrication.

STARTING MOTOR

Starting motor end frames are equipped with oil-less bearings which do not require lubricant.

DISTRIBUTOR LUBRICATION

Distributor cap should be removed every 100 hours.

Apply small amount of Delco-Remy Cam and Ball Bearing Lubricant or other suitable high-melting point, non-bleeding grease on distributor cam surface.

Add a drop of light engine oil to breaker lever pivot.

STERN DRIVE LUBRICATION SERVICE

1. Clean entire unit thoroughly externally.
2. Inspect finish for damage or corrosion. Thoroughly clean damaged or corroded areas and apply matching paint (Quicksilver Spray Paints).
3. Check entire unit for loose, damaged or missing parts. Tighten or replace as required.
4. Remove propeller and inspect. Trim nicks and burrs with a file, being careful not to remove more metal than absolutely necessary. Inspect for cracks, damaged or bent condition. If condition is doubtful, refer to an Authorized Quicksilver Propeller Repair Station in your area.
5. Check propeller shaft for bent condition. Shaft should be replaced if it is found to be bent.
6. Check lubricant level as outlined, following.
7. Coat propeller shaft splines with Perfect Seal No. 4 (C-92-34227-1) and install propeller. (Figure 1)

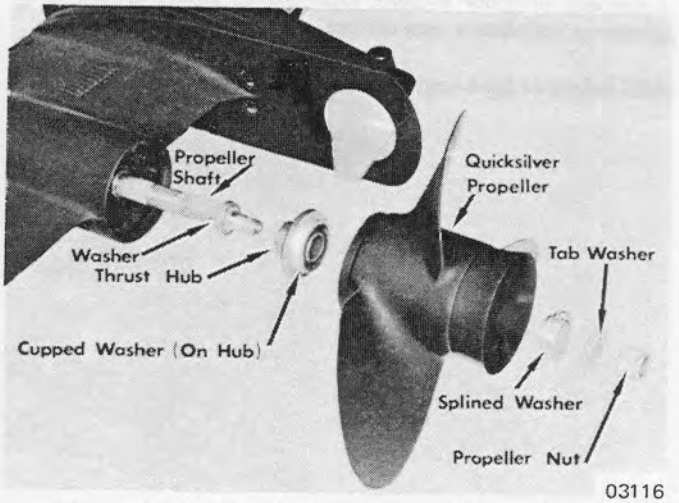

Figure 1. Propeller Shaft and Propeller Components

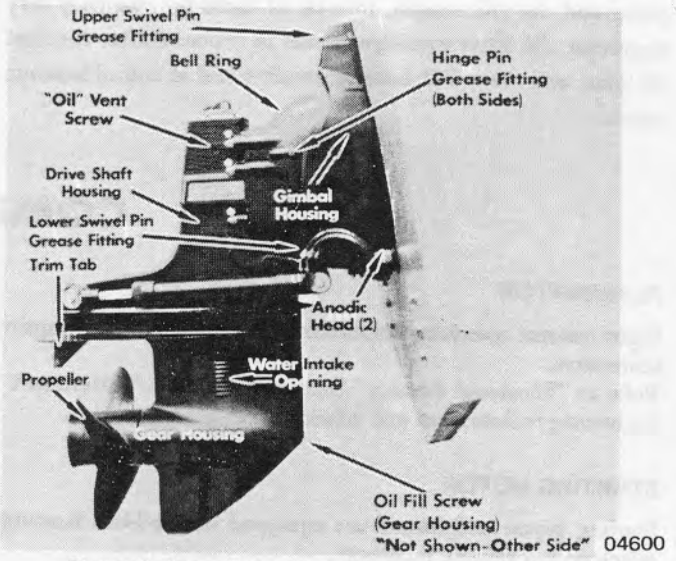

Figure 2. Stern Drive Unit Components - Right Side

8. Inspect universal joint bellows, shift cable bellows, water intake hose and exhaust tube for deterioration and damage. Service as required. Check all clamps for tightness.
9. Check reverse lock mechanism for free operation. Lubricate and service as required.
10. Check tilt or trim for proper operation and connections. (Figure 2)
11. Check and adjust engine alignment as outlined in Section 2.
12. Check and adjust shift cables as outlined in Section 2.
13. Lubricate all external lubrication points with Multipurpose Lubricant (C-92-49588).
14. Check crank-up mechanism (if applicable) and make adjustments as necessary.

CHECKING LUBRICANT LEVEL

WARNING: DO NOT remove vent or filler plug when drive is hot from operation. Expanded hot gear lubricant would be released thru plug hole. Check only when stern drive unit is cool.

CAUTION: DO NOT use regular automotive grease in stern drive unit.

Use only Quicksilver Super-Duty Gear Lubricant (C-92-56101-1, 120 lb. drum; C-92-56565-1, 37 lb. pail; C-92-52655-12, cans; C-92-52650-12, tubes) in all MerCruiser stern drive units. Lubricant should be changed once every 100 hours of operation, or once each season.

MERCRUISER "O" (60-80-90HP)

NOTE: Upper drive shaft housing gear chamber and lower unit gear chamber are connected.

1. Remove "Oil Vent" plug and gasket, located on side of drive shaft housing. (Figure 1) Lubricant must be even with bottom edge of threaded "Oil Vent" hole when unit is level.
2. Add Super-Duty Gear Lubricant, if level is down. Remove "Oil Fill" plug and gasket (located on opposite side of drive shaft housing). Add lubricant thru "Fill" hole until oil appears at "Vent" hole.

   NOTE: Only a small amount of lubricant should be added thru drive shaft housing "Fill" hole. If drive unit is empty, drive must be filled as shown in "Draining and Filling Drive Unit", following.

3. Install "Oil Vent" and "Oil Fill" plugs with new seal gaskets.

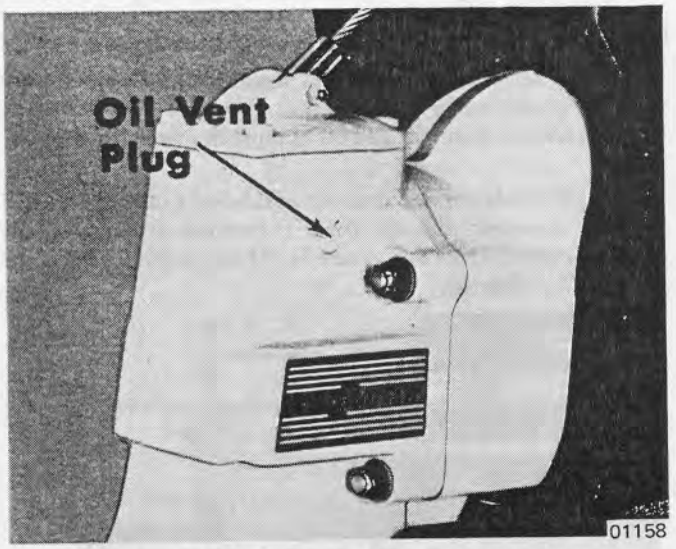

Figure 1. Oil Vent Plug in Upper Gear Chamber

MERCRUISER I-IA-IB-IC and IA-IB-IC E-Z Shift

NOTE: Upper drive shaft housing gear chamber and lower unit gear chamber are SEPARATE oil chambers.

Upper Gear Chamber

1. Remove "Oil Vent" plug and gasket, located on side of drive shaft housing. (Figure 2) Lubricant must be even with bottom edge of threaded "Oil Vent" hole when unit is level.
2. Add Super-Duty Gear Lubricant, if level is down. Remove "Oil Fill" plug and gasket (located on opposite side of drive shaft housing). Add lubricant thru "Fill" hole until oil appears at "Vent" hole.
3. Install "Oil Vent" and "Oil Fill" plugs with new seal gaskets.

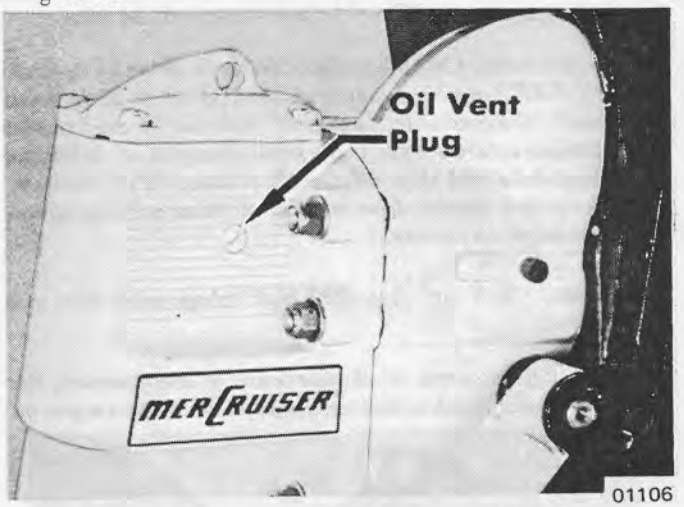

Figure 2. Oil Vent Plug in Upper Gear Chamber

Lower Gear Chamber

1. Remove "Oil Vent" plug and gasket located on side of gear housing just above anti-cavitation plate. (Figure 3) Lubricant must be even with bottom edge of threaded oil "Vent" hole when unit is level.
2. Add Super-Duty Gear Lubricant, if level is down. Remove "Oil Fill" plug and gasket (located on lower side of gear housing). (Figure 3) Add lubricant thru "Fill" hole until oil appears at "Vent" hole.

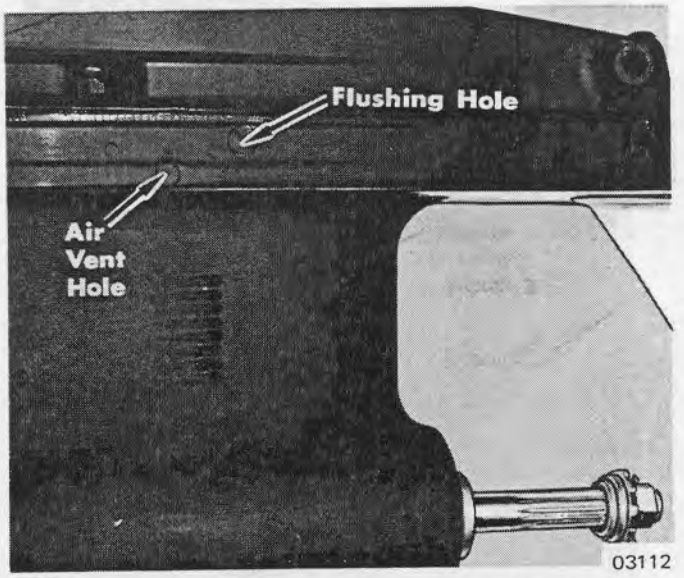

Figure 3. Oil Vent and Oil Fill Hole in Lower Gear Chamber

3. Install "Oil Vent" and "Oil Fill" plugs with new seal gaskets.

MERCRUISER 120-140-160-165-888

NOTE: Upper drive shaft housing gear chamber and lower unit gear chamber are connected.

1. Remove "Oil Vent" plug and gasket on side of drive shaft housing. (Figure 4) Lubricant must be even with bottom edge of threaded "Oil Vent" hole when unit is level.
2. Add Super-Duty Gear Lubricant, if level is down. Remove "Oil Fill" hole plug and gasket (located on lower side of gear housing). (Figure 5) Add lubricant thru "Fill" hole until oil appears at "Vent" hole in drive shaft housing.

   NOTE: Some 120-140-160-165 Stern Drive units have an "Oil Fill" hole on opposite side of drive shaft housing from "Oil Vent" hole. This "Fill" hole can be used to add lubricant to drive unit. Only small amounts of lubricant should be added thru drive shaft housing "Fill" hole. If drive unit is empty, drive must be filled as in Paragraph 2, immediately preceding.

3. Install "Oil Vent" and "Oil Fill" plugs with new seal gaskets.

   NOTE: Since the 2 oil chambers are inter-connected, the lower gear housing will automatically maintain a proper oil level, if the upper gear chamber oil level is maintained according to above instructions.

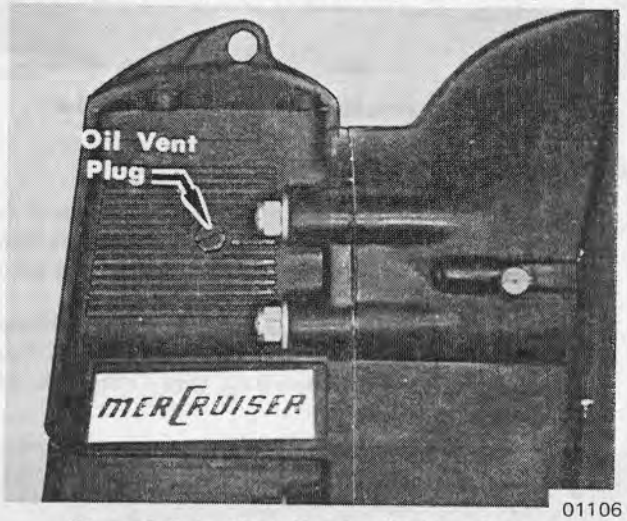

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Figure 4. Drive Shaft Housing Oil Vent Plug

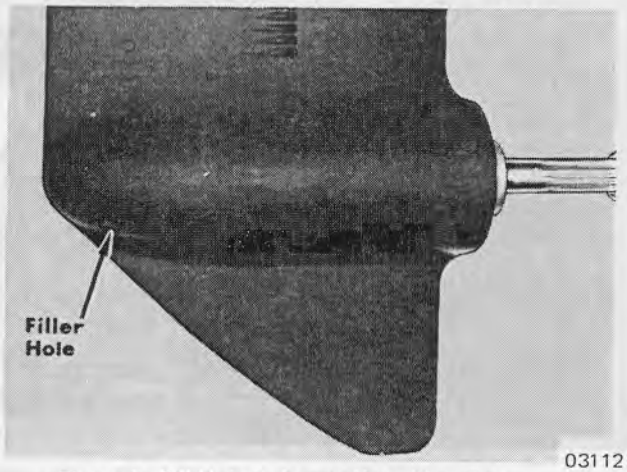

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Figure 5. Fill Hole in Lower Gear Chamber

MERCRUISER II

1. Remove lubricant filler plug and gasket (located in center of rear cover). (Figure 6) Lubricant must be even with bottom edge of threaded hole.
2. Add Super-Duty Gear Lubricant thru fill hole, if oil level is down.

   NOTE: Only a small amount of lubricant should be added thru drive shaft housing "Fill" hole. If drive unit is empty, drive must be filled as shown in "Draining and Filling Drive Unit", following.

3. Install filler plug and new seal gasket.

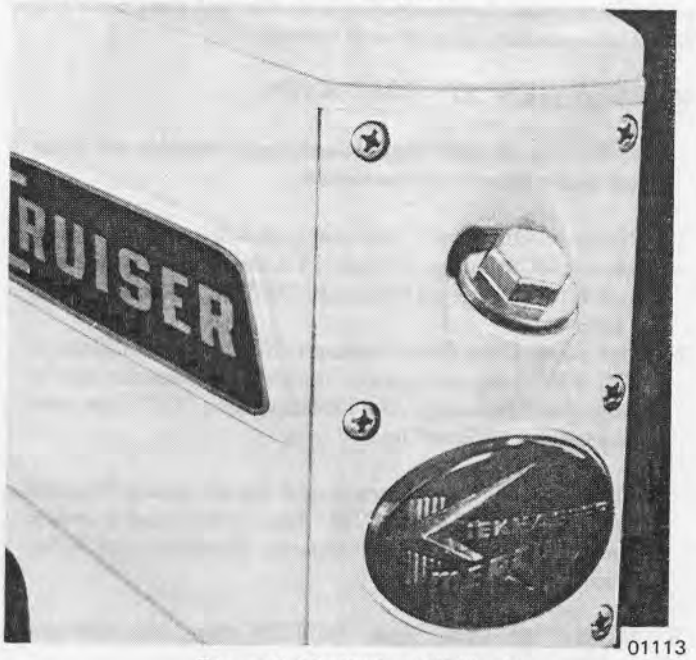

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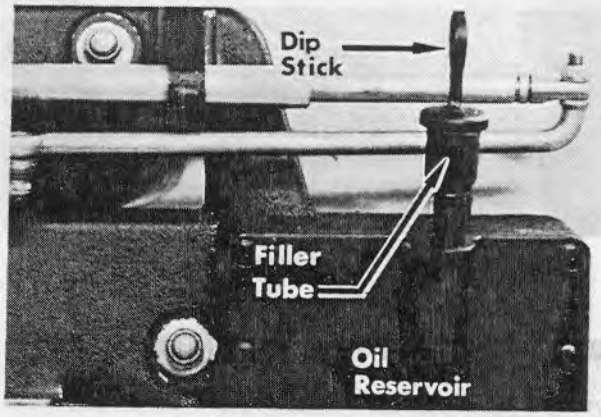
Figure 6. MerCruiser II Filler Plug

MERCRUISER 215-225II-TR and 255II-TR

Check oil level frequently with dipstick (located on inner transom plate) when unit is cool. (Figure 7) If oil level is below mark on dipstick, add oil to dipstick mark thru dipstick tube.

NOTE: Only a small amount of lubricant should be added thru reservoir dipstick tube. If reservoir is empty, drive unit must be filled as shown in "Draining and Filling Drive Unit", following.



04588

Figure 7. Checking Stern Drive Unit Oil Level

Oil level of stern drive unit should be checked frequently and oil added if required. Check oil level in sight glass (located on inner transom plate) when unit is cool. (Figure 8) If oil level is not visible in sight glass, remove oil fill plug (located in oil reservoir) and add oil, as required, to bring level up to line on sight glass.

NOTE: Only a small amount of lubricant should be added thru oil reservoir fill plug. If reservoir is empty, drive unit must be filled as shown in "Draining and Filling Drive Unit", following.

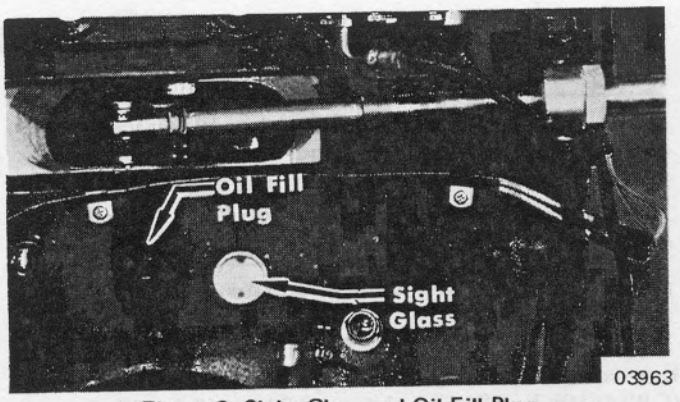


Figure 8. Sight Glass and Oil Fill Plug

DRAINING and FILLING DRIVE UNIT

WARNING: DO NOT remove vent or filler plug when drive is hot from operation. Expanded hot gear lubricant would be released thru plug hole. Check only when stern drive unit is cool.

CAUTION: DO NOT use regular automotive grease in stern drive unit.

Use only Quicksilver Super-Duty Gear Lubricant (C-92-56101-1, 120 lb. drum; C-92-56565-1, 37 lb. pail; C-92-52655-12, cans; C-92-52650-12, tubes) in all MerCruiser stern drive units. Lubricant should be changed once every 100 hours of operation or once each season. Do not attempt to fill drive unit with lubricant in any other manner than that described immediately following. Any other method may result in damage caused by lack of lubrication.

MERCRUISER 60-80-90-120-140-160-165-888-II

NOTE: Upper drive shaft housing gear chamber and lower unit gear chamber are connected.

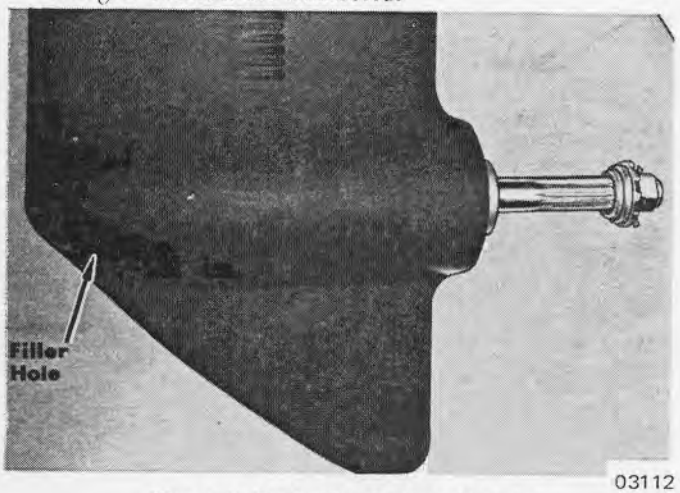


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Figure 1. Drain Plug in Gear Housing

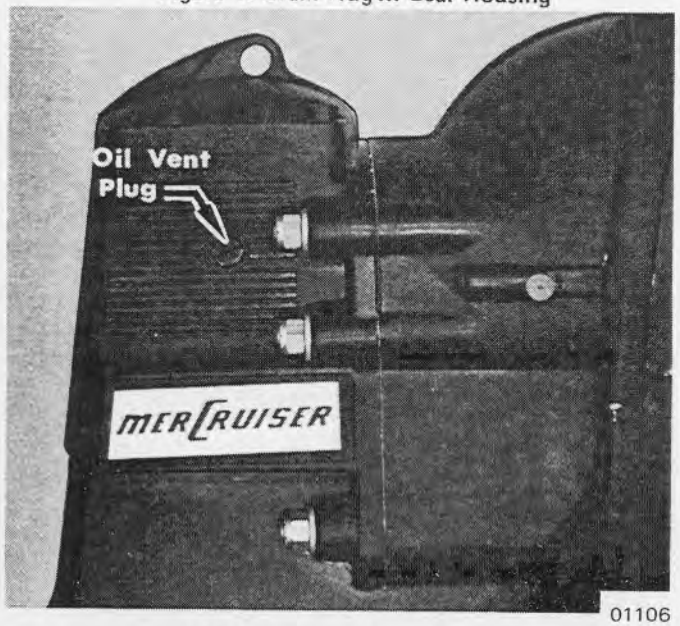

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Figure 2. Oil Vent Plug in Upper Gear Chamber

1. Drain stern drive unit by removing drain plug from lower end of gear housing on left side (Figure 1) and vent plug on upper gear chamber. (Figure 2)
2. To refill drive unit, insert lubricant tube into drain plug hole in lower unit (Figure 1) and inject lubricant until excess fluid starts to flow out of air vent hole in upper drive shaft housing. (Figure 2)
3. Install air vent and drain plugs, taking special care that washer is in place under head of each so water will not leak past threads into gear housing.

MERCRUISER I-IA-IB-IC and IA-IB-IC E-Z SHIFT

NOTE: Upper drive shaft housing gear chamber and lower unit gear chamber are SEPARATE oil chambers.

Upper Gear Chamber

1. To drain upper gear chamber, remove drive unit top cover. (Figure 3) Use a pump to remove lubricant. If drive unit has been removed from transom, unit can be tipped to drain lubricant.
2. Remove "Oil Fill" and "Oil Vent" plugs and gaskets (located on right and left sides of drive shaft housing). (Figure 3) Install top cover and "O" ring. Torque screws to specifications. (Refer to Section 8 "Specifications".)
3. Insert lubricant tube into filler plug hole and inject lubricant until excess fluid starts to flow out of "Oil Vent" screw hole with unit level.
4. Install "Oil Vent" and "Oil Fill" plugs and new seal washers.

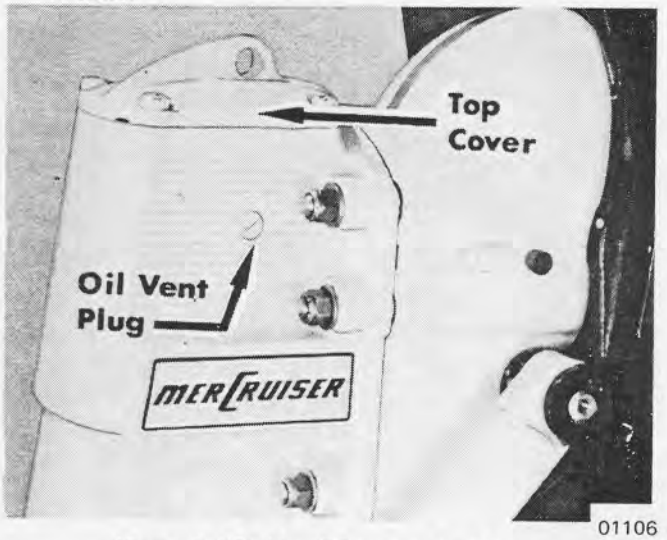

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Figure 3. "Oil Vent" Plug and Top Cover

Lower Gear Chamber

1. To drain gear housing, remove filler (drain) plug and gasket from lower end of gear housing on left side (Figure 4) and oil vent plug and gasket (located just above anti-cavitation plate). (Figure 4)
2. To fill gear housing, insert lubricant tube into filler plug hole and inject lubricant until excess fluid starts to flow out of oil vent plug hole when unit is level. (Figure 4)
3. Install oil vent and oil fill plugs and new seal washers.

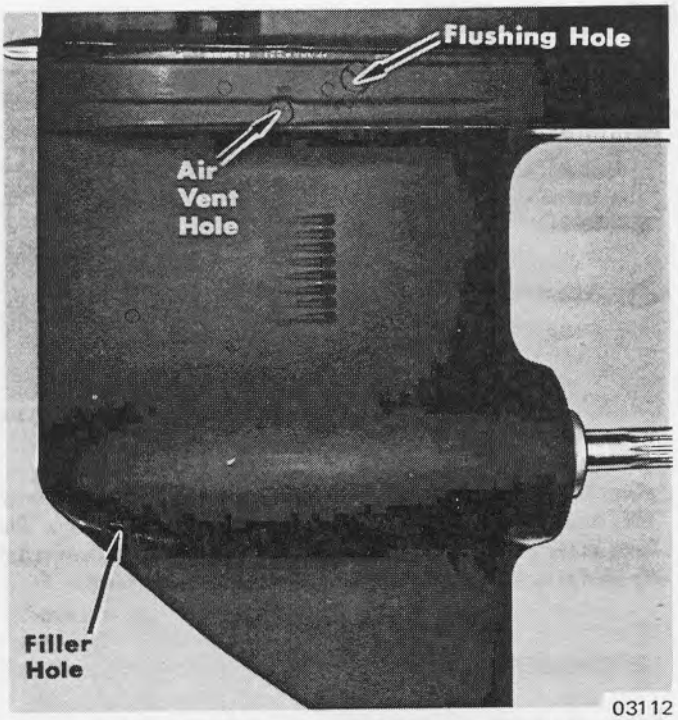


Figure 4. Oil Vent and Oil Fill Hole in Lower Gear Chamber

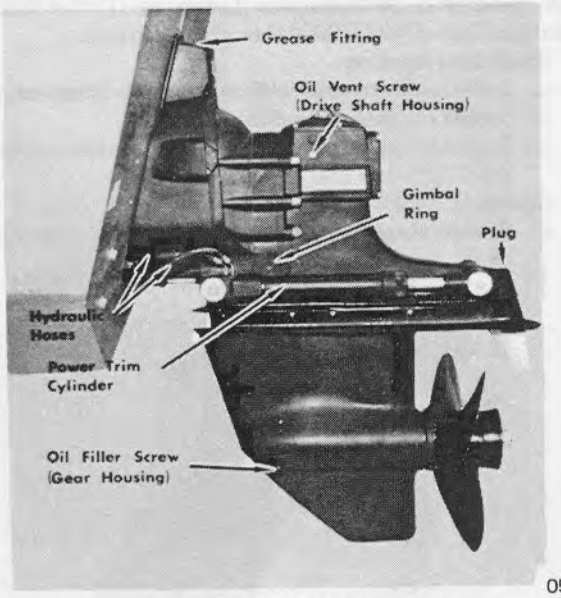


Figure 5. Oil Fill and "Oil Vent" Plugs

NOTE: To drain drive unit completely, drive must be installed in bell housing. (Figure 5)

1. Remove oil fill and "Oil Vent" plugs (Figure 5) and allow oil to drain completely.
2. To fill drive unit, install drive shaft housing "Oil Vent" plug. Drive unit must be filled with a hand-type lubricant pump thru gear housing oil fill hole. Unit must be filled until lubricant level meets line on sight glass (Figure 6) or dipstick (Figure 7) (located on inner transom plate reservoir).
3. After filling, thread oil fill plug (with new gasket under head) into gear housing and tighten securely.

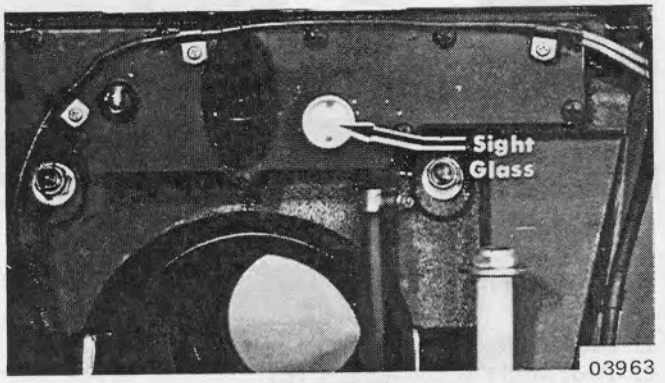


Figure 6. Sight Glass MerCruiser III

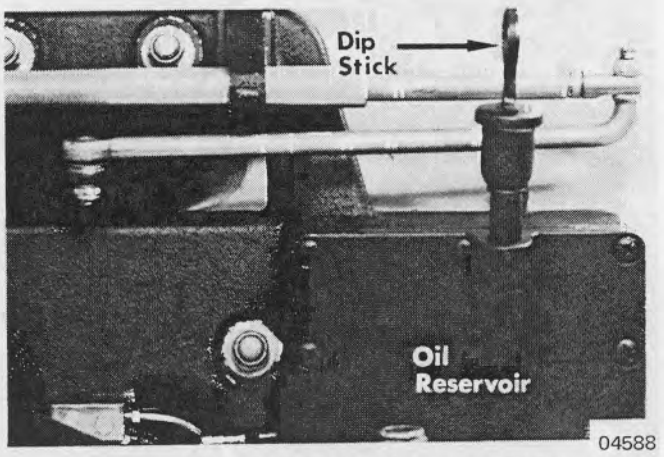


Figure 7. Dipstick-215-225II-TR and 255II-TR

POINTS of LUBRICATION

MERCRUISER "O" (60-80-90 HP)

Every 50 hours of operation, or at least once a season, lubricate the various MerCruiser "O" Stern Drive components with Quicksilver Multipurpose Lubricant (C-92-49588) and Lubricant Gun (C-91-37299) thru grease fittings:

Figure 1. Lubrication Point, Inside of Boat, Right Side

INSIDE BOAT (Figures 1-2)

1. Ride-Guide steering cable end next to hand nut. (A)
2. Pivot socket of steering arm. (B)
3. Exposed cable traversing thru cable guide tube. (C)

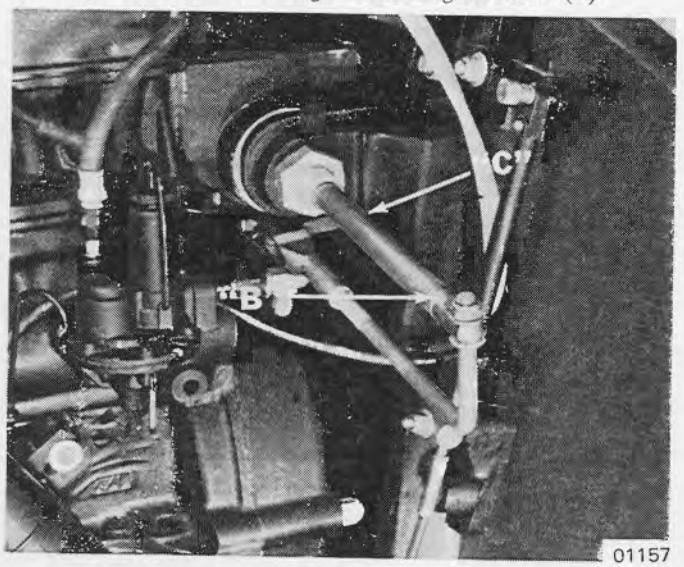


Figure 2. Lubrication Points, Inside of Boat, Left Side

OUTSIDE BOAT (Figure 3)

1. Gimbal housing upper pivot pin.
2. All pivot points on bell housing shift shaft with Anti-Corrosion Grease (C-92-45134).

STERN DRIVE LUBRICANT

Every 50 hours of operation, check lubricant level of the MerCruiser "O" Stern Drive Unit. *(NOTE: Upper drive shaft housing gear chamber and lower unit gear chamber are connected.)* If filling is required, use only Super-Duty Quick-silver Gear Lubricant (C-92-52650). Change lubricant every 100 hours of operation or at least once each season. The MerCruiser Stern Drive Unit should be checked before initial operation to be certain that lubricant is at correct level.

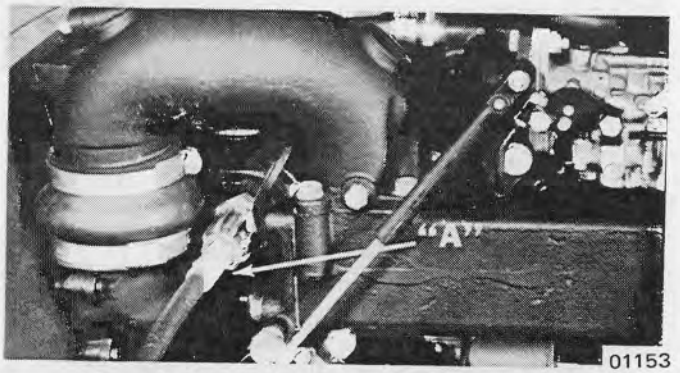


Figure 3. Outside Lubrication and Oil Fill Plug

MERCRUISER I-thru-888

Every 50 hours of operation, or at least once a season, lubricate the various MerCruiser I Stern Drive components with Quicksilver Multipurpose Lubricant (C-92-49588) and Lubricant Gun (C-91-37299) thru grease fittings:

1. Inside boat location
   a. Ride-Guide steering cable end next to hand nut. (A)
   b. Socket of pivot of steering arm. (B)
   c. Exposed shaft of cable traversing thru cable guide tube. (C)
2. Outside of boat
   a. Gimbal housing upper and lower pivot pin. (Figure 4 or 5)

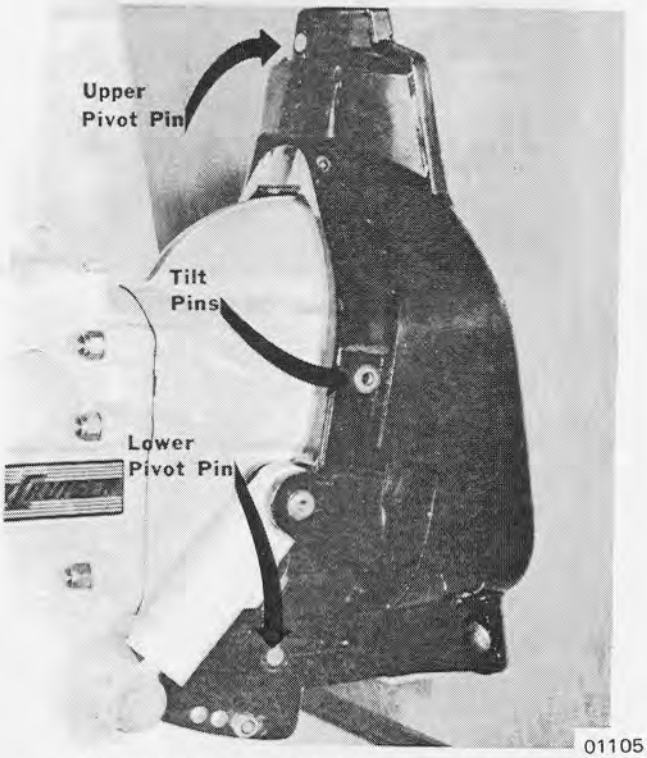


Figure 4. Points of Lubrication, Early Models

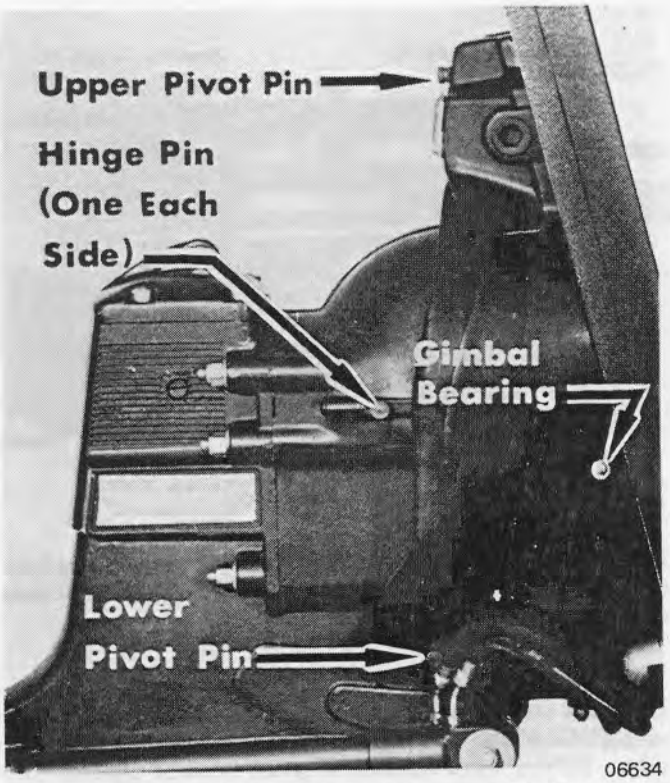


Figure 5. Points of Lubrication, Late Models

b. Tilt pins on both sides of gimbal ring. (Figure 4 or 5)

NOTE: On early models, tapered end of Lubricant Gun (C-91-30500) fits counterbore. (Figure 3) No fitting is used; however, if difficulty is encountered in forcing grease into tilt pin (Figure 6), install fitting B-22-37668 in tilt pin. Grease fitting B-22-37668 must be removed after lubrication.

c. Gimbal bearing.

3. Lubricate universal joint bearings with Universal Joint Lubricant (C-92-58229-1).

MERCRUISER II-200-225

Every 50 hours of operation, or at least once a season, lubricate the various MerCruiser II-200-225 Stern Drive components with Quicksilver Multipurpose Lubricant (C-92-49588) and Lubricate Gun (C-91-30500) thru grease fittings:

1. Inside boat location (Figure 7)
   a. Ride-Guide steering cable end next to hand nut
   b. Inner transom mounting plate
      1) Left side at base of crank unit
      2) Right side top for crank ring gear
   c. Inside steering lever housing for steering lever shaft
2. Outside of boat (Figure 8 or 9)
   a. Gimbal housing upper and lower pivot pin
   b. Tilt pins on both sides of gimbal housing

Figure 9. Late Gimbal Housing Lubrication

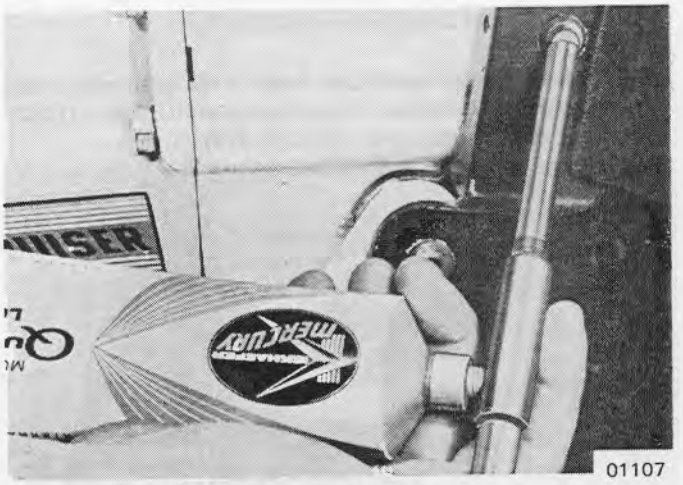


Figure 6. Lubricating Tilt pins

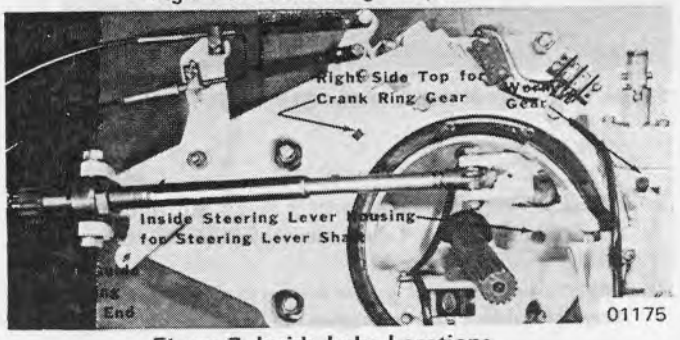


Figure 7. Inside Lube Locations

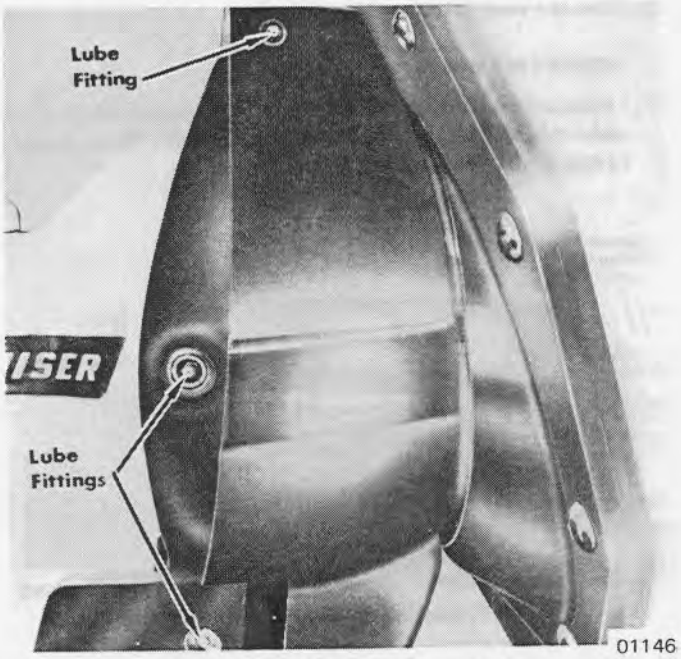
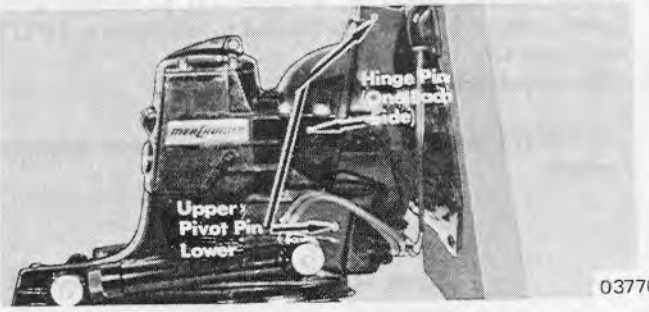


Figure 8. Outside Lube Locations



Lubricate drive unit upper and lower pivot pin thru grease fitting with Quicksilver Anti-Corrosion Grease (C-92-45134A1) and Lubricant Gun (C-91-37299).

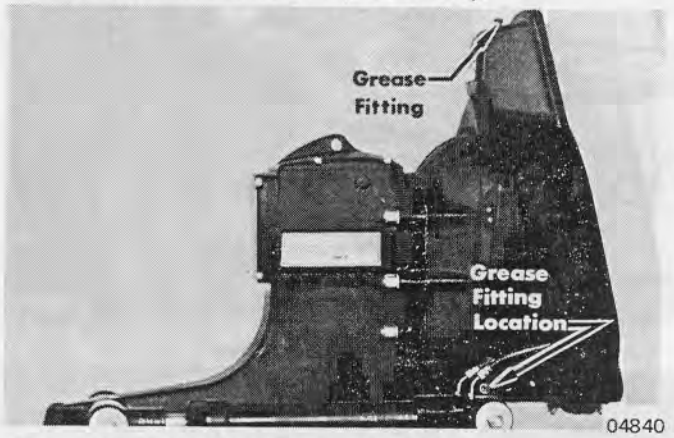


Figure 10. Points of Lubrication - 215-225II-TR and 255II-TR

MANUAL STEERING

1. Lubricate steering cable with a small amount of Quicksilver Multipurpose Lubricant (C-92-49588) thru grease fitting. ("A" in Figure 11)
2. Apply a light coat of grease to the exposed portion of the steering cable ("B" in Figure 11) and to steering lever pivot points ("C" in Figure 11).
3. Do not over-lubricate cable.

POWER STEERING

1. Lubricate steering cable with a small amount of Quicksilver Multipurpose Lubricant (C-92-49588) thru grease fitting. ("A" in Figure 12)

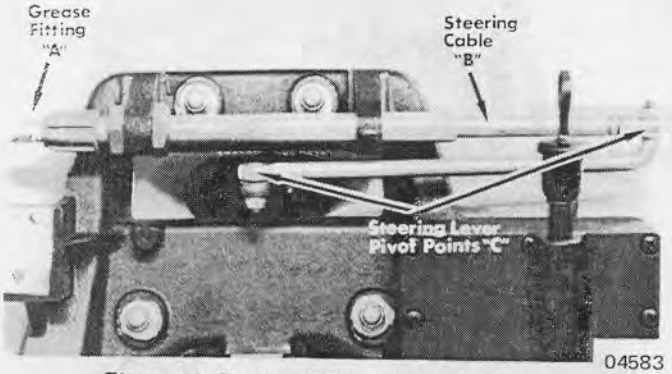


Figure 11. Steering Cable Lubrication Points

2. Apply a light coat of grease to the exposed portion of the Power Steering cable ("B" in Figure 12), to steering lever pivot points ("C" in Figure 12) and to extension rod ("D" in Figure 12).
3. Do not over-lubricate cable.

NOTE: If a dual tie bar is installed, also lubricate its pivot points.

Figure 14. Power Steering Lubrication

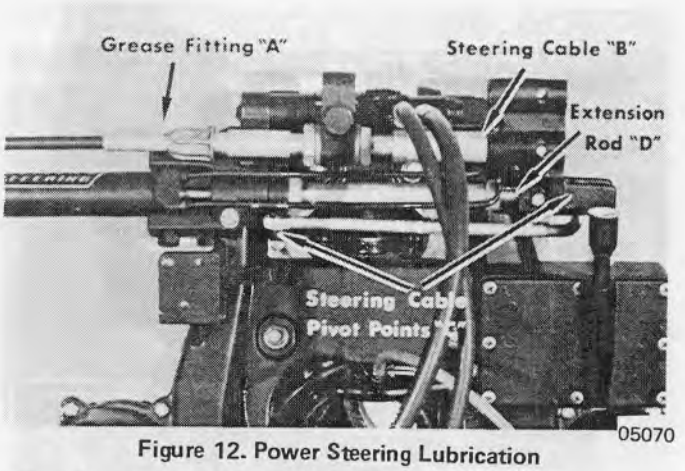


Figure 12. Power Steering Lubrication

MERCRUISER III

Lubricate drive unit upper pivot pin thru grease fitting with Quicksilver Multipurpose Lubricant (C-92-49588) and Lubricant Gun (C-91-37299).

MANUAL STEERING

Lubricate steering cable with Quicksilver Multipurpose Lubricant (C-92-49588) thru grease fitting. Do not over-lubricate cable. Only a small amount of grease need be injected thru fitting. (Figure 13) Also apply a coating of grease to the exposed portion of steering cable.

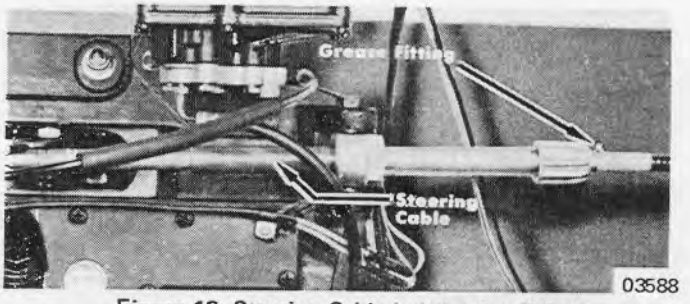
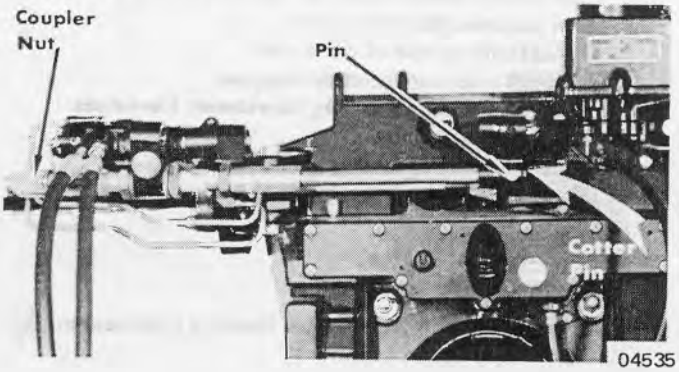


Figure 13. Steering Cable Lubrication Points

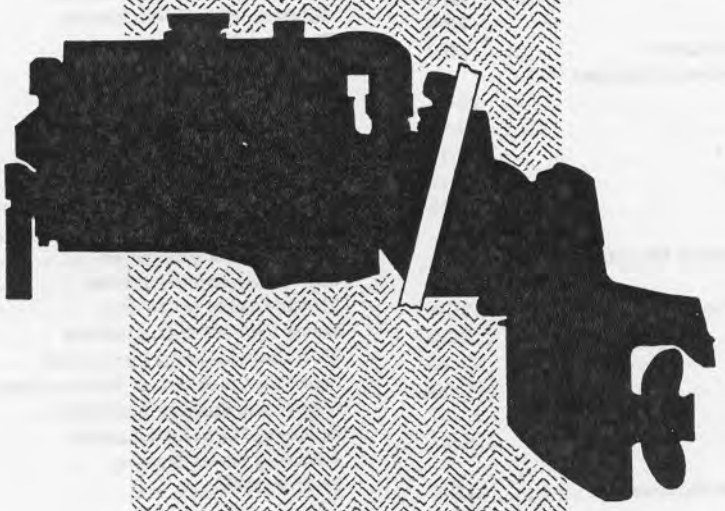
POWER STEERING

1. Lubricate steering cable with a small amount of Quicksilver Multipurpose Lubricant (C-92-49588) thru grease fitting. ("A" in Figure 14)
2. Apply a light coat of grease to the exposed portion of the Power Steering cable ("B" in Figure 14) and to steering lever pivot points ("C" in Figure 14).
3. Do not over-lubricate cable.

NOTE: If a dual tie bar is installed, also lubricate its pivot points.



MERCRUISER
SECTION 2



REMOVAL-INSTALLATION-
ALIGNMENT

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SECTION 2 - REMOVAL, INSTALLATION and ALIGNMENT

MERCRUISER

PART A - MERCRUISER 60-80-90

STERN DRIVE

MERCURY MARINE

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MERCRUISER "60" ENGINE REMOVAL

NOTE: Engine components are secured with standard U.S. nuts and screws, except where noted. When metric tools are required, sizes will be indicated.

1. Disconnect battery cables from battery and remove instrument panel harness connector plug from engine harness receptacle.
2. Disconnect throttle and shift control cables.
3. Disconnect Ride-Guide steering cable from steering rod.
4. Loosen locknut and remove steering rod from steering clevis.
5. Remove cotter pin and washer and remove clevis pin and clevis from steering arm.
6. Disconnect tilt switch leads from ignition coil and condenser mounting bracket. (Figure 1)

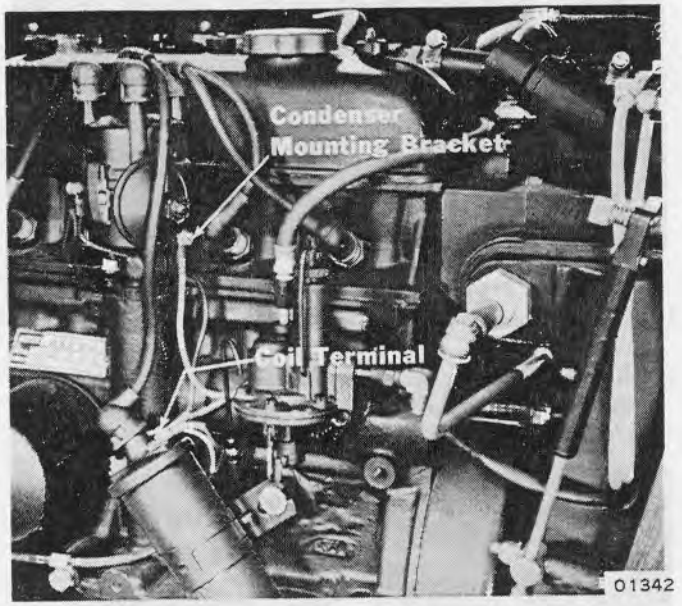


Figure 1. Tilt Switch Leads

7. Remove hydraulic shift unit from mounting bracket and shift lever. DO NOT remove hydraulic lines from hydraulic shift unit. (Figure 2)

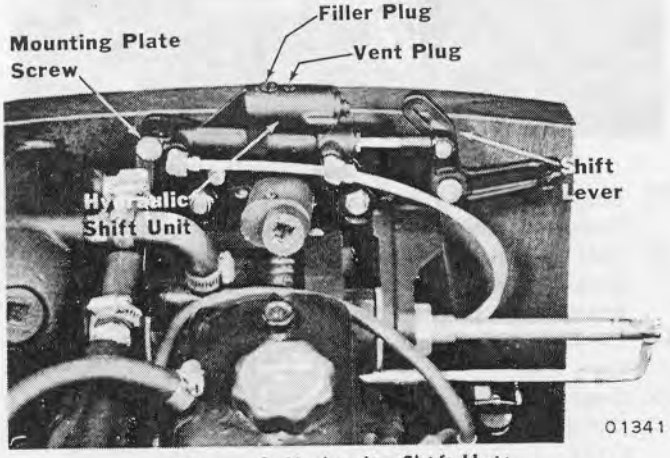


Figure 2. Hydraulic Shift Unit

8. Install suitable sling thru lifting eyes on engine and secure to overhead hoist.
9. Remove nuts and washers from lower transom plate mounting screws and remove screws. (Figure 3)

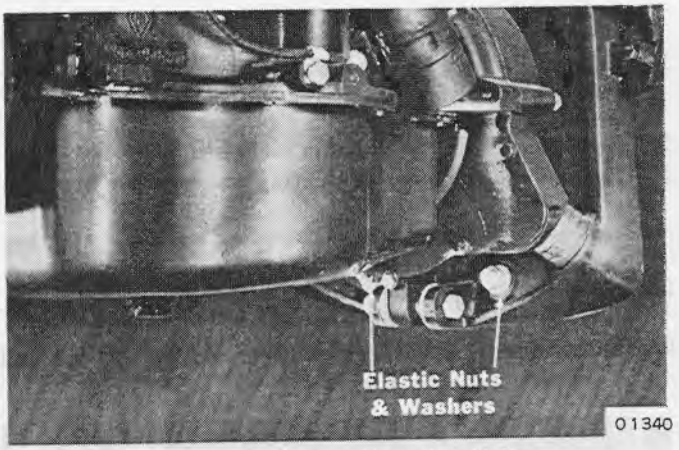


Figure 3. Bottom Mounting Bolts

10. Remove manual tilt-up cable from top cover of stern drive unit.
11. Remove nuts and washers from upper transom mounting screws. Remove screws and manual crank-up unit from transom. (Figure 4)

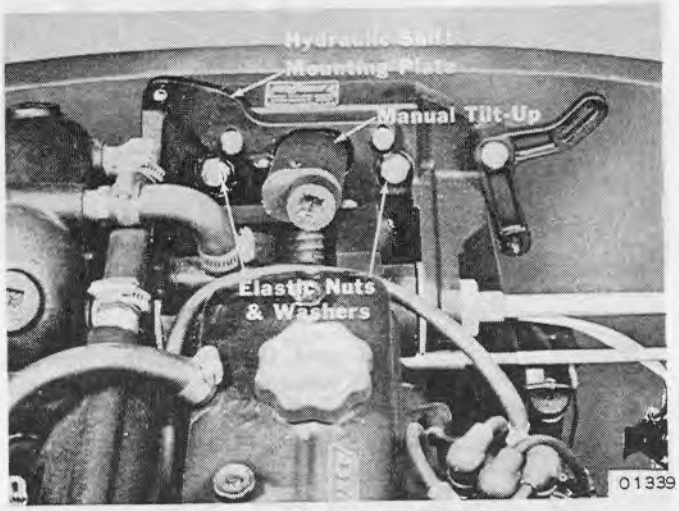


Figure 4. Manual Tilt-Up Unit

12. Before removing engine, check again that no wires, lines, etc , are attached to engine.
13. Pull engine forward approx. 4" (101.4mm). This will permit inner transom plate to disengage from stern drive unit. Engine then may be lifted straight up.
14. Cooling system and crankcase may be drained at this time.
15. Remove oil filter, ignition coil and fuel pump and install engine on engine stand.

NOTE: Ignition coil is secured with 2 screws, one 14mm hex-headed screw and one 10mm hex-headed screw. Fuel pump is secured with a 12mm nut and a 12mm screw.

MERCRUISER "80" and "90" ENGINE REMOVAL

NOTE: Engine components are secured with standard U.S. nuts and screws, except where noted. When metric tools are required, sizes will be indicated.

1. Disconnect battery cables from battery and remove instrument panel harness connector plug from engine harness receptacle.
2. Disconnect fuel line, throttle and shift control cables.
3. Disconnect Ride-Guide steering cable from steering rod.
4. Loosen locknut and remove steering rod from steering clevis.
5. Remove cotter pin and washer and remove clevis pin and clevis from steering arm.
6. Disconnect tilt switch leads from engine harness and at starter solenoid. (Figure 1)

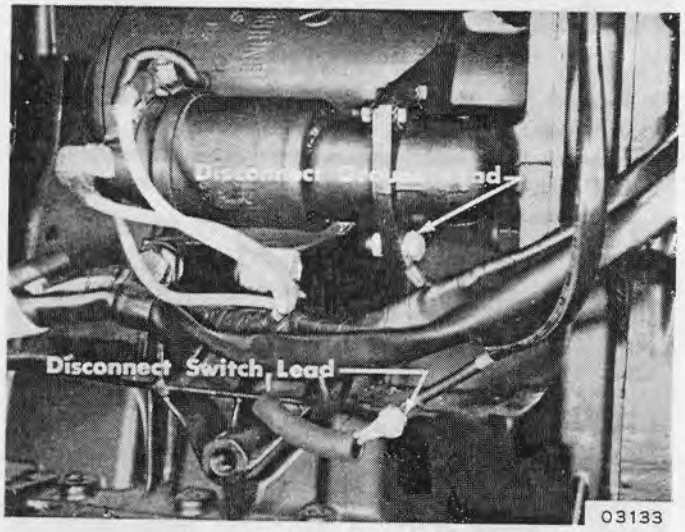


Figure 1. Tilt Switch Leads

7. Remove hydraulic shift unit from mounting bracket and shift lever. DO NOT remove hydraulic lines from hydraulic shift unit. (Figure 2)

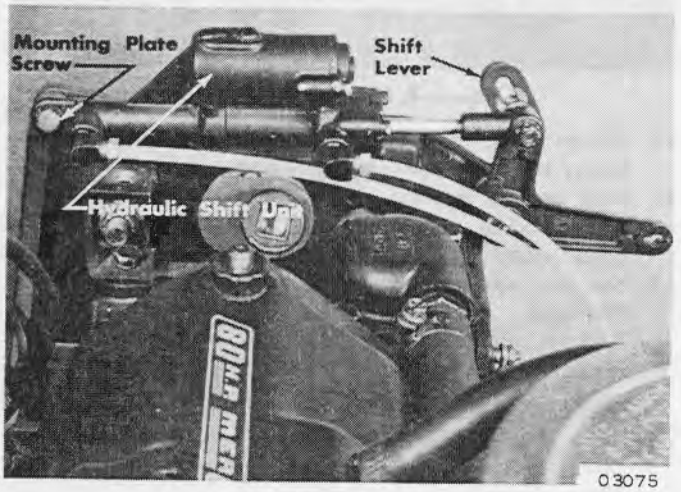


Figure 2. Hydraulic Shift Unit

8. Install suitable sling thru lifting eyes on engine and secure to overhead hoist.
9. Remove nuts and washers from lower transom plate mounting screws and remove screws. (Figure 3)

Figure 3. Bottom Mounting Bolts

10. Remove manual tilt-up cable from top cover of stern drive unit.
11. Remove nuts and washers from upper transom mounting screws. Remove screws and manual crank-up unit from transom. (Figure 4)

Figure 4. Manual Tilt-Up Unit

12. Before removing engine, check again that no wires, lines, etc, are attached to engine.
13. Pull engine forward approx. 4" (10cm). This will permit inner transom plate to disengage from stern drive unit. Engine then may be lifted straight up.
14. Cooling system and crankcase may be drained at this time.
15. Remove oil filter, ignition coil, oil sending unit and fuel pump and install engine on engine stand.

NOTE: Fuel pump is secured with 12mm nuts and 12mm pal nuts.

ENGINE INSTALLATION

NOTE: Prior to engine installation, gimbal housing must be installed.

1. Apply a liberal coat of New Multipurpose Lubricant (C-92-49588) to water tube (located on gimbal housing) and guide bar and exhaust tube (located on inner transom plate). (Figure 1)
2. Lift engine with an overhead hoist, using suitable sling and lifting eyes on engine.
3. Align exhaust tube and guide bar on inner transom plate with guide bar groove and exhaust tube opening on gimbal housing.
4. Guide engine into position, while watching water tube on gimbal housing, to be sure that tube enters hole in inner transom plate.

IMPORTANT: Exercise care while lining up engine, since rocking the engine from side-to-side can damage water tube seal which is located in the inner transom plate. If this seal is damaged, water will leak around the inner transom plate, and replacement of the seal will require removing the engine.

5. Insert manual tilt unit (Figure 2) or hydraulic inlet cover (Figure 3) and hoses thru transom opening from outside of boat and position on transom. It may be necessary to move the hydraulic shift unit mounting plate up or down to provide clearance for tilt unit. (Figure 4)

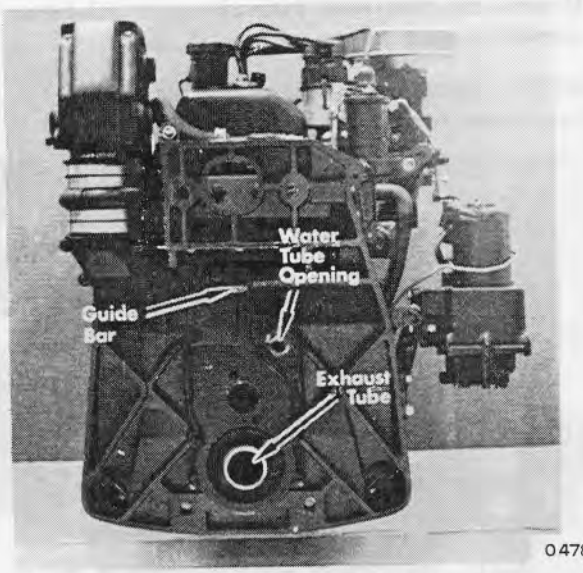


Figure 1. Typical Inner Transom Plate Guide and Exhaust Tube

NOTE: MerCruiser "60" and "80" Power Tilt hose is routed to port side.

6. Place washers on 2 carriage bolts, as shown in Figure 5 or 6, as required, and insert bolts from outside of boat thru tilt unit, transom and inner transom plate.

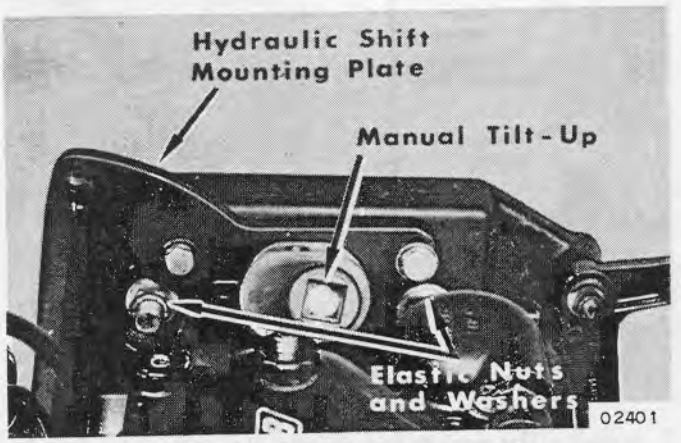


Figure 2. Manual Tilt Unit Installed

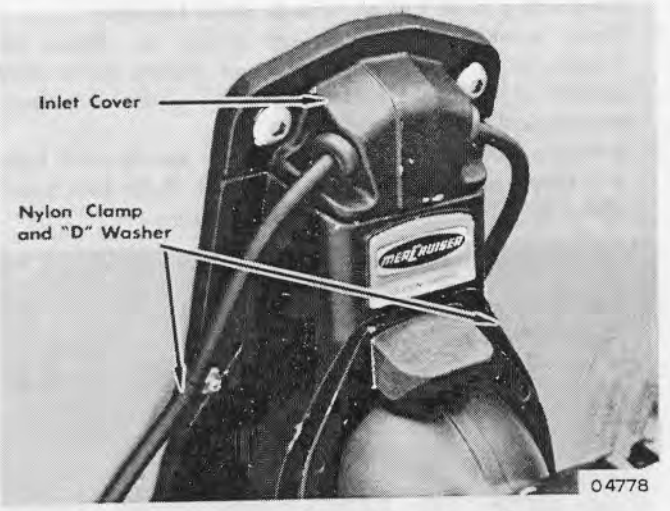


Figure 3. Installing Inlet Cover and Hoses

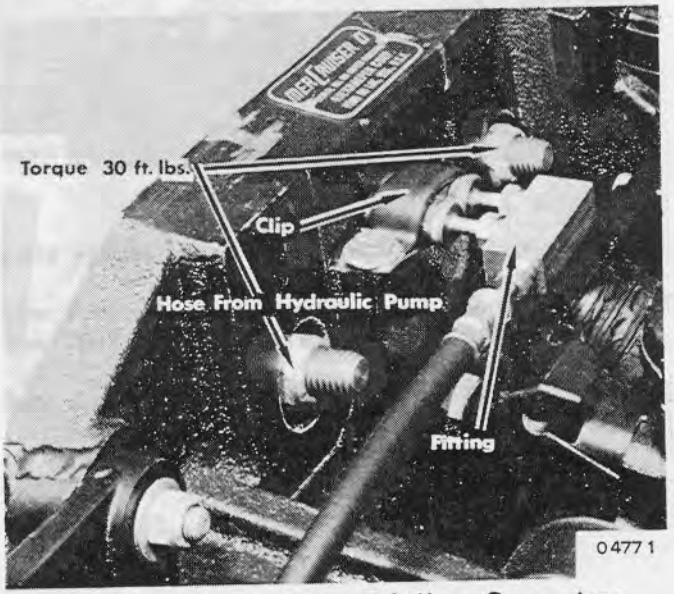


Figure 4. Hydraulic Power Tilt Hose Connections

NOTE: Earlier carriage bolts ONLY require sealing washer. Care should be exercised to keep transom seal in position when tightening bolts.

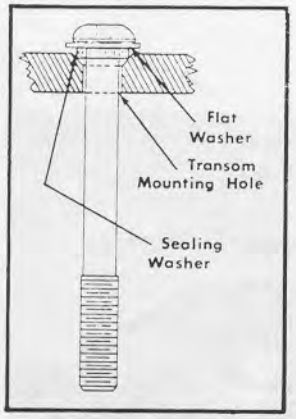


Figure 5.

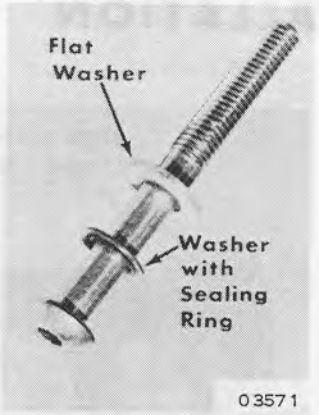


Figure 6.

Carriage Bolt Washer Locations

7. Install a flat washer and elastic stop nut on each bolt and torque to 20-25 ft.lbs. (2.77-3.46mkg). Hold bolt head with a 5/16" allen wrench while torquing.
8. Place washers on 2 carriage bolts, as shown in Figure 5 or 6, as required, and insert bolts from outside of boat thru bottom holes of gimbal housing, transom and inner transom plate.
9. Install a flat washer and elastic stop nut on each bolt and torque to 20-25 ft.lbs. (Figure 7) Hold bolt head with a 5/16" allen wrench while torquing.

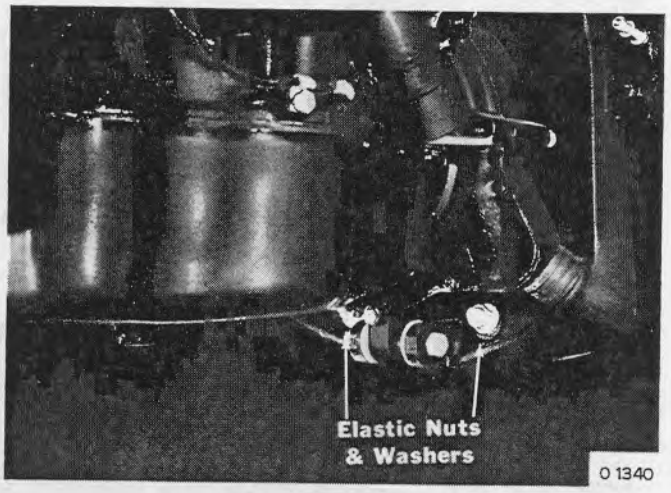


Figure 7. Bottom Mounting Bolts

10. Relieve tension on overhead hoist and remove sling from engine.
11. Tighten screws which secure hydraulic shift unit mounting plate to inner transom plate of "60" and "80" models only.
12. Place hydraulic shift unit piston on shift lever stud and position hydraulic shift unit to mounting (or transom) plate with cap screw, spacer, washers and nut. (Figure 8 or 9)
13. Fasten hydraulic shift unit piston to shift lever mounting stud with spacer, washer and elastic stop nut. DO NOT tighten nut securely, as piston must pivot freely on stud.

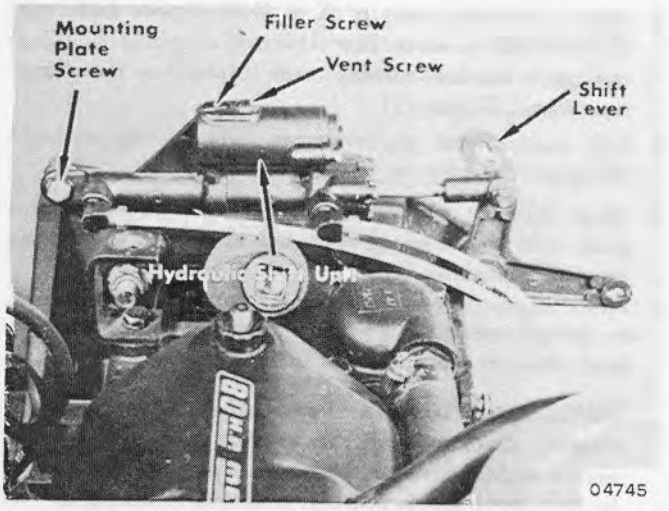


Figure 8. Hydraulic Shift Unit Installed MerCruiser "60" and "80"

14. Mount hydraulic tilt hose to transom plate with large metal clip, screw and washer. (Figure 4)
15. Remove cap from pump hydraulic hose and fitting and quickly connect to prevent loss of oil.

NOTE: Engine alignment is not necessary for this type engine mounting.

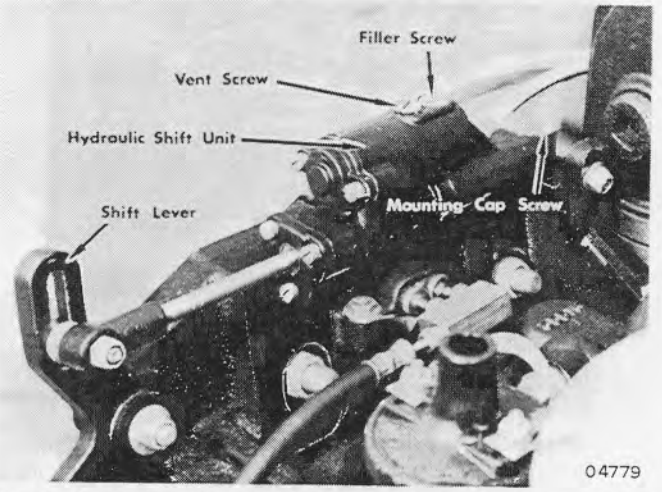


Figure 9. Hydraulic Shift Unit Installed - MerCruiser "90"

STERN DRIVE INSTALLATION

1. Lubricate drive shaft housing pilot and drive shaft splines with New Multipurpose Lubricant (C-92-49588). (Figure 1)
2. Position intermediate shift shaft coupler (located in drive unit) straight ahead, as shown in Figure 1.

NOTE: It may be necessary to rotate propeller shaft to position coupler.

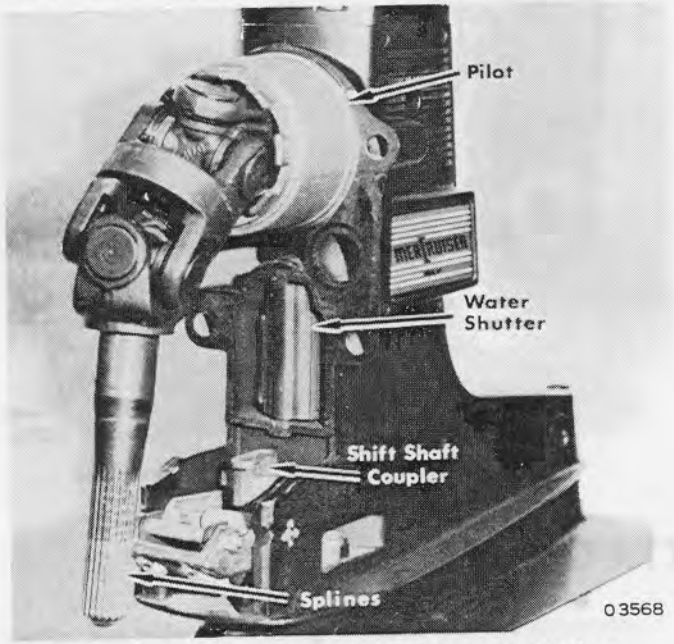


Figure 1. Drive Unit Prepared for Installation

3. Check position of water shutter. Be sure that tabs on shutter are in recesses in drive shaft housing. (Figure 1)
4. Lubricate inside surfaces of bell housing bore and upper shift shaft coupler with New Multipurpose Lubricant (C-92-49588). (Figure 2)
5. Place drive shaft housing to bell housing gasket in position on bell housing. (Figure 2)
6. Position upper shift shaft coupler (located in bell housing) straight ahead, as shown in Figure 2, by moving shift lever (located inside boat) to the left (port) as far as lever will move.

> **CAUTION: If upper and intermediate shift shaft couplers are not positioned as outlined in preceding Steps 2 and 6, bell housing and couplers will be damaged when installing drive unit.**

7. Insert stern drive unit into bell housing, guiding drive shaft thru gimbal housing bearing into engine coupling. If drive shaft splines do not align with engine coupling splines, rotate propeller shaft counterclockwise until drive unit can be pushed into position.
8. Fasten drive shaft housing to bell housing with 4 elastic stop nuts and flat washers. Tighten nuts evenly and torque to 40 ft. lbs. (5.3mkg).
9. Attach manual tilt-up cable to top cover of stern drive unit (Figure 3) on "60" and "80" models. *This step does not apply to units with Power Tilt.*

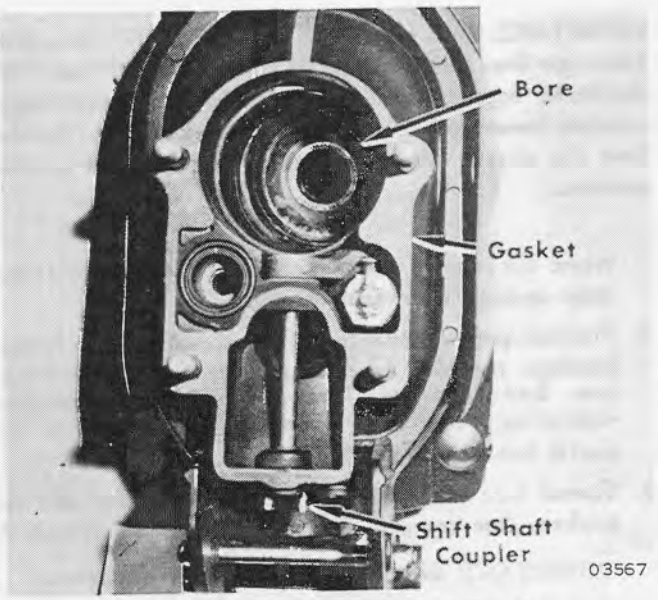


Figure 2. Bell Housing Prepared for Drive Unit Installation

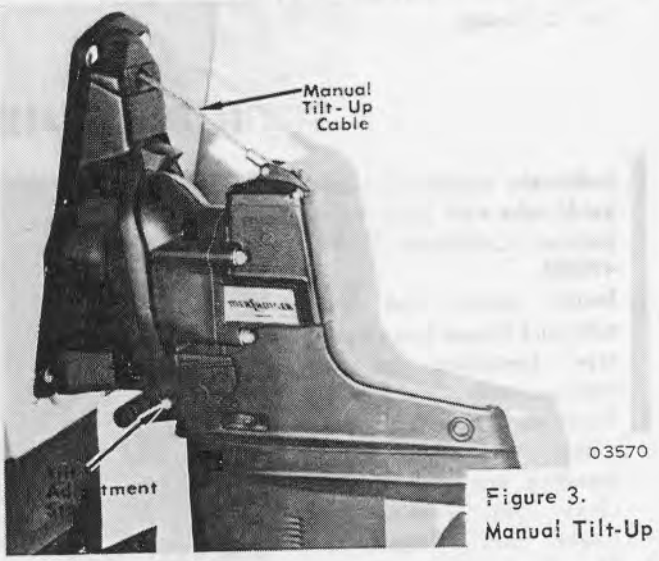


Figure 3. Manual Tilt-Up

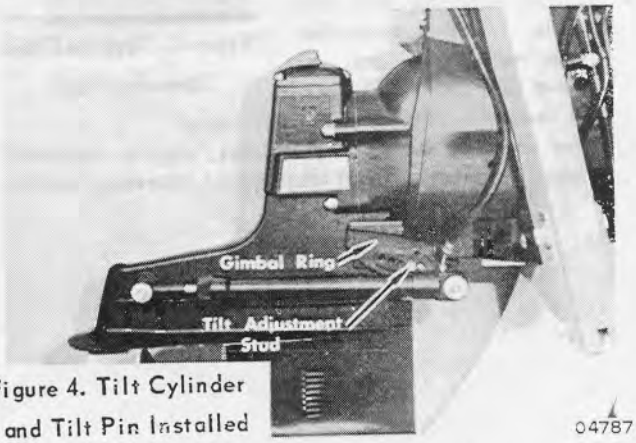


Figure 4. Tilt Cylinder and Tilt Pin Installed

10. Install tilt adjustment stud in gimbal ring (Figure 4) and tilt cylinders, as required.

GIMBAL HOUSING INSTALLATION

IMPORTANT: MerCruiser "60", "80" & "90" Stern Drive Units are designed for MerCruiser "60", "80" and "90" 4-cylinder engines which have standard automotive engine rotation (counterclockwise when viewing engine flywheel from the rear). All drive units are right hand propeller rotation.

1. Insert tilt switch leads and hydraulic shift unit thru large opening in transom. (Figure 5)
2. Position gimbal housing on transom and, while holding housing, position supporting plate on inside of transom. Insert hex head screws with lockwashers thru supporting plate and transom. Thread screws into gimbal housing. (Figure 5)
3. Thread hex head screws with lockwashers and flat washers thru transom into gimbal housing. (Figure 5)

   IMPORTANT: Do not attempt to drive screws thru transom, as threads in gimbal housing will be damaged.

4. Tighten hex head screws evenly and torque to 20 ft. lbs. (2.76mkg).

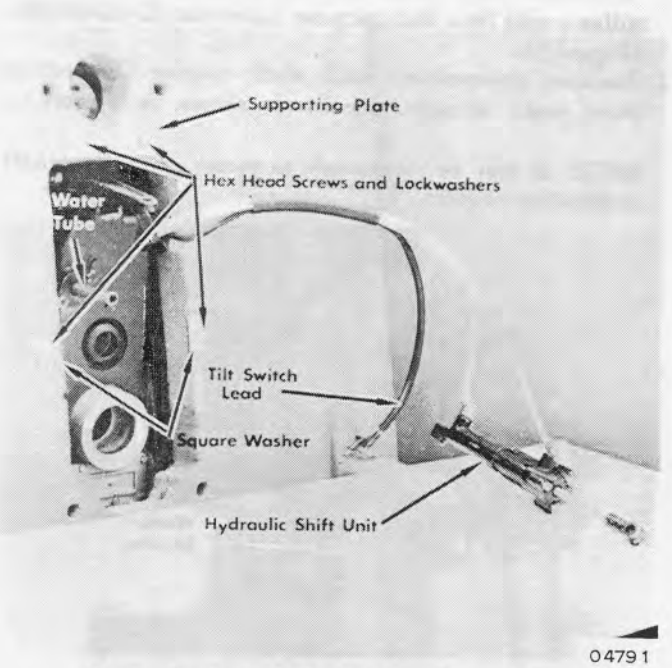


Figure 5. Typical Gimbal Housing Installed

RIDE-GUIDE ATTACHMENT

1. Lubricate inside of cable guide tube with New Multipurpose Lubricant (C-92-49588).
2. Insert cable end thru tube and thread large hand-type fastening nut on tube securely.
3. Position steering rod clevis on stern drive steering arm and install clevis pin, washer and cotter pin. (Figure 1)
4. Thread steering rod into clevis and assemble cable on steering rod, as shown in Figure 2. Tighten nut securely, then back off ¼-turn.
5. Turn steering wheel until gimbal ring is centered in gimbal housing. If, at this point, steering wheel is not centered, remove steering rod from cable and adjust steering rod in clevis to center steering wheel. Reinstall steering rod, as outlined in Step 4, after completing adjustment, and tighten locknut securely against clevis.

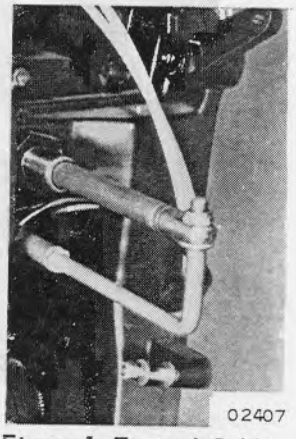


Figure 1. Typical Cable Steering Rod

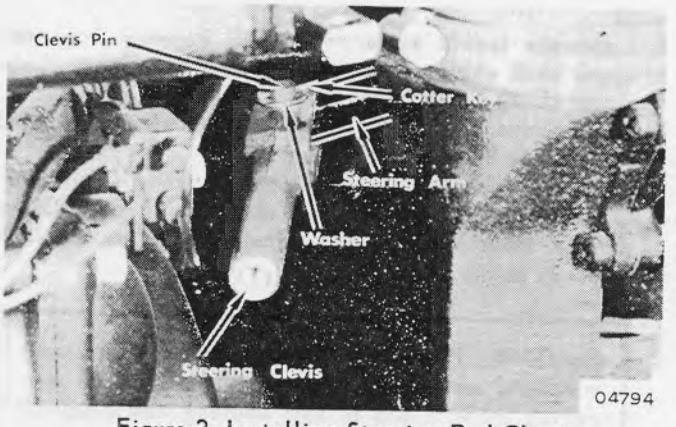


Figure 2. Installing Steering Rod Clevis

SHIFT CABLE ATTACHMENT

1. Move remote control handle to full forward.
2. Pull shift lever out as far as it will go. This shifts stern drive unit into forward gear. While shifting, turn propeller shaft counterclockwise until shaft stops (to ensure full clutch engagement).
3. Loosen hydraulic shift unit piston anchor stud, move anchor stud to bottom of shift lever slot and tighten nut. Place remote control shift cable end guide on shift lever. (Figure 3 or 4)

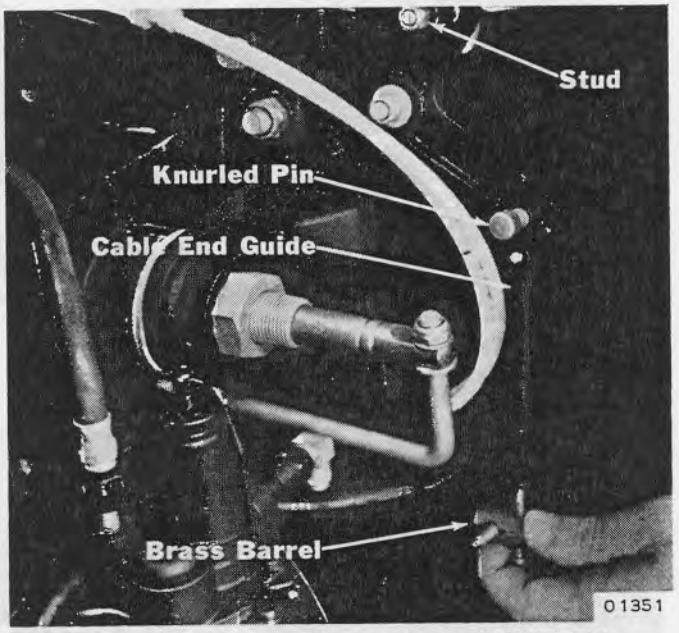


Figure 3. Adjusting Remote Control Shift Cable - MerCruiser "60" and "80"

4. Pull outer shift cable away from cable guide, as far as possible, and adjust brass barrel on remote control shift cable to align with mounting stud on transom plate anchor point. (Figure 3)
5. Fasten brass barrel with spacer, washers and nut. Tighten nut securely. For Power Tilt, secure hydraulic hose with nygrip clamp and "D" washer.
6. Disconnect remote control shift cable end guide from shift lever.
7. Move remote control handle to full reverse.
8. Manually push shift lever in as far as it will go. This shifts stern drive unit into reverse. While shifting, rotate propeller shaft clockwise until shaft stops, to assure full clutch engagement.
9. Loosen hydraulic shift unit piston anchor stud and move up slot in shaft lever until cable end guide can be reinstalled. (Figure 5 or 6)
10. Securely tighten nut on stud which fastens hydraulic shift unit piston to shift lever.

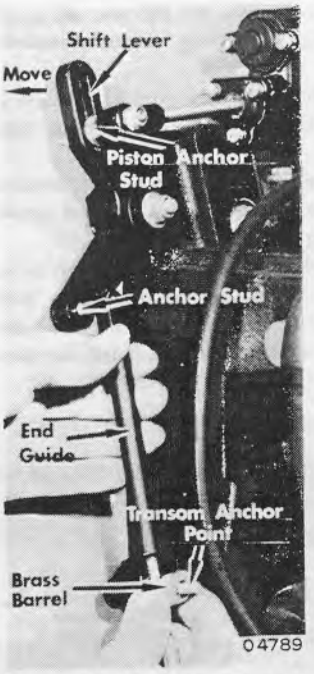


Figure 4. Adjusting Remote Control Shift Cable - MerCruiser "90"

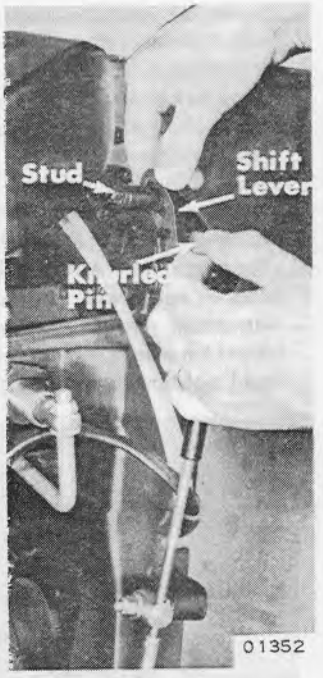


Figure 5. Reverse Adjustment - MerCruiser "60" and "80"

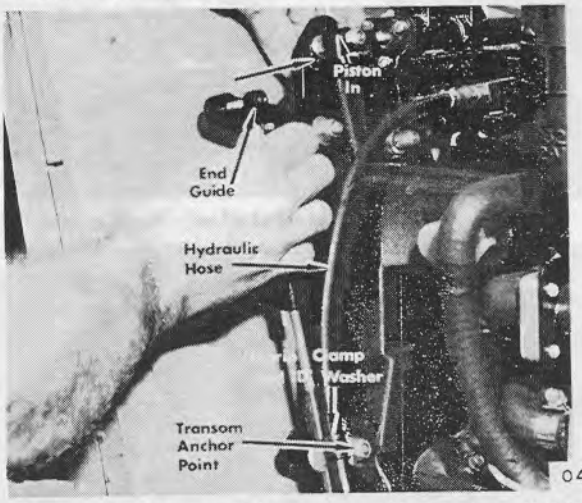


Figure 6. Reverse Adjustment - MerCruiser "90"

11. Install hydraulic shift tubes on MerCruiser "60" shift sender unit (mounted on inner transom plate assembly) by attaching long hydraulic tube to left inlet (looking aft from inside boat). Attach short tube to right inlet.
12. Attach short tube to upper inlet of shift receiver (located in bell housing) and long tube to lower inlet of shift receiver.

THROTTLE CABLE ATTACHMENT

1. Refer to installation instructions, which are shipped with remote control, when installing remote control and cables.
2. Fasten throttle cable to side and transom of boat with clips to form a gradual bend leading to anchor stud and throttle arm.
3. Place remote control handle in neutral and neutral warmup lever down before attaching cable end guide or brass barrel to attaching points.
4. Grasp throttle cable behind brass barrel and push in on cable end guide. Adjust brass barrel to align with attaching points. Place flat washer, sleeve and barrel on stud. Place flat washer and stop nut on stud and tighten nut securely . (Figures 7-8-9-10-11)

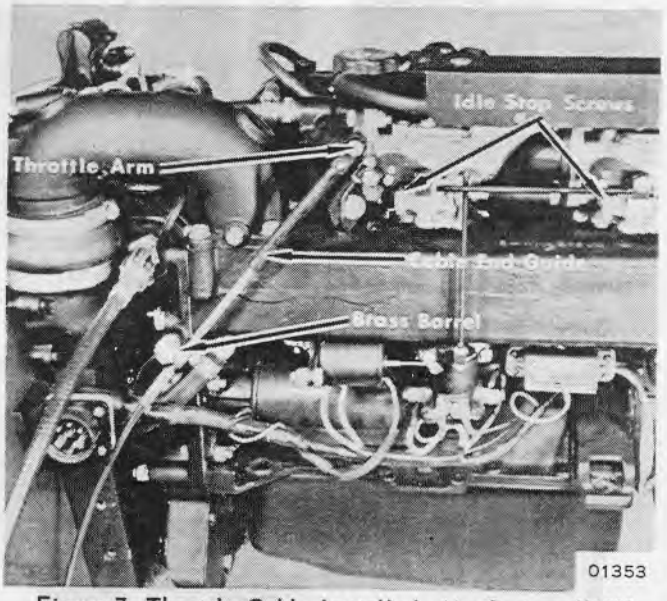


Figure 7. Throttle Cable Installed - MerCruiser "60"

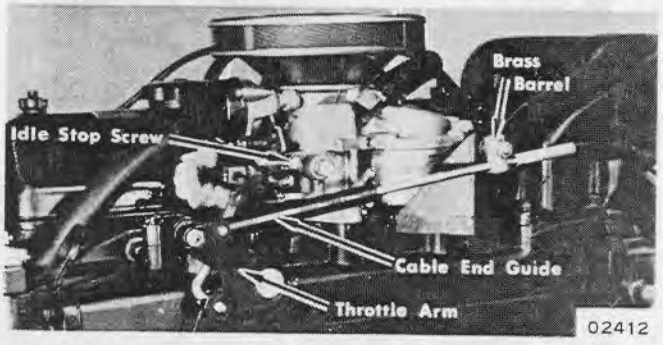


Figure 8. Throttle Cable Installed - Early MerCruiser "80"

5. Check that throttle valves are fully open when remote control handle is all the way forward. Return control handle to neutral and check for fully-closed throttle valves.
6. Set engine idle RPM in forward gear by adjusting idle stop screw on carburetor. Turn screw in to increase RPM; back screw out to decrease RPM.

CAUTION: DO NOT operate engine without cooling water flowing thru water pump, or neoprene water pump impeller will be damaged.

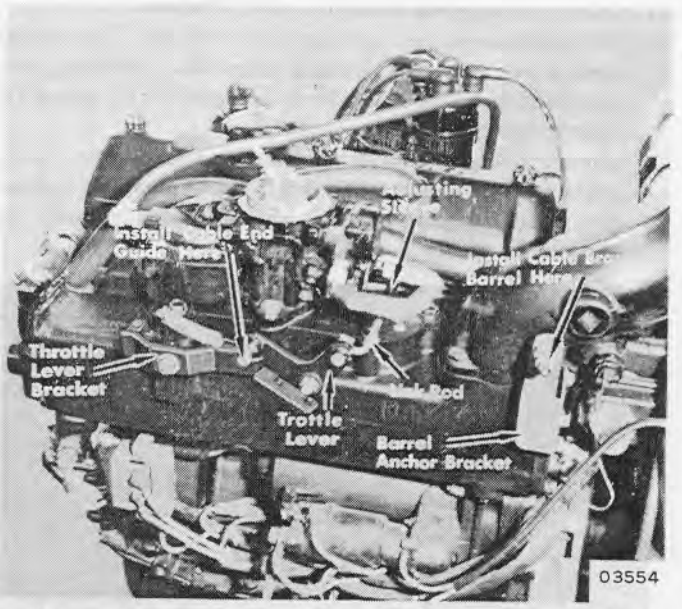


Figure 9. Throttle Cable Installed - MerCruiser "80" (Carburetor with Reverse Kit)

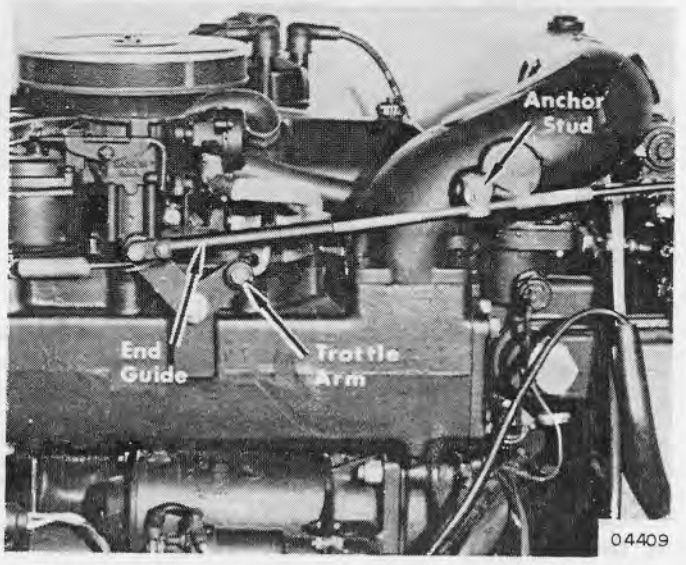


Figure 10. Throttle Cable Installed - MerCruiser "80"

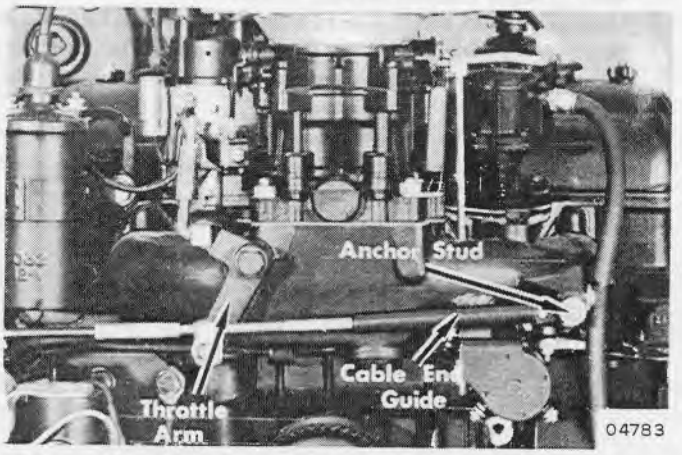


Figure 11. Throttle Cable Installed - MerCruiser "90"

TILT and SHOCK CYLINDER INSTALLATION

1. Insert aft anchor pin in drive shaft housing and assemble parts as shown in Figure 1 or 2.
2. Insert forward anchor pin in gimbal ring.
3. Place parts required on each side of anchor pin. (Figure 3 or 4)

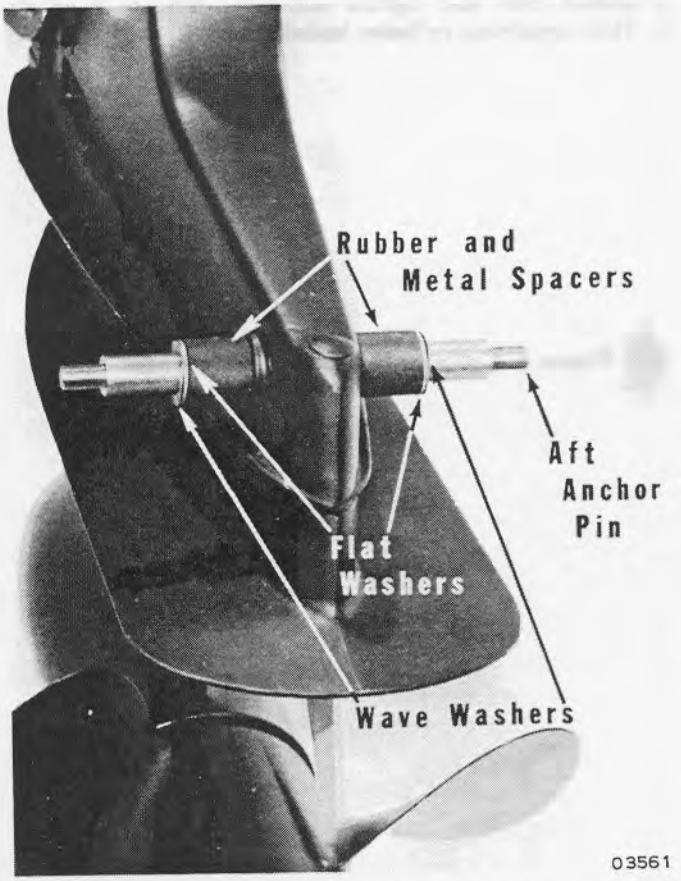


Figure 1. Installing Aft Anchor Pin

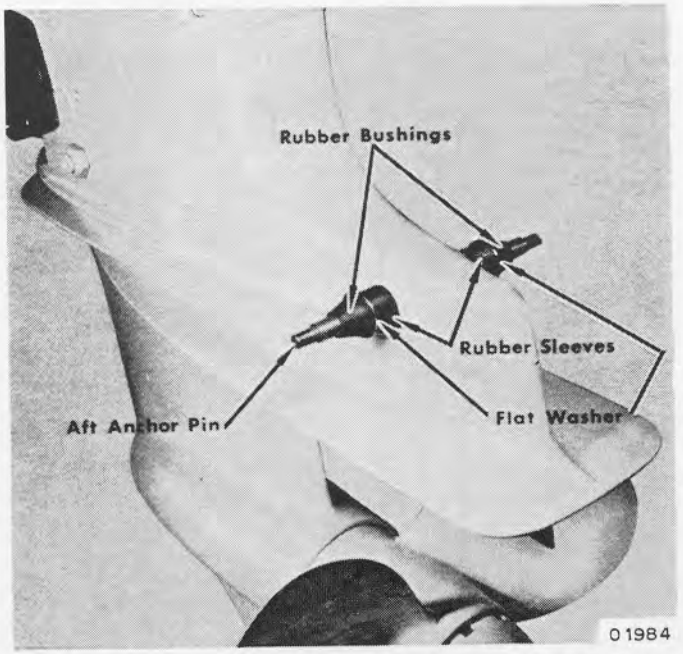


Figure 2. Installing Aft Anchor Pin - Early Models

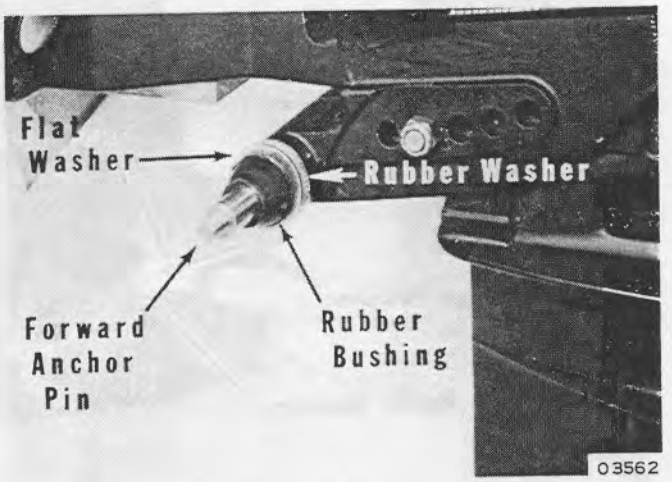


Figure 3. Installing Forward Anchor Pin

Figure 4. Installing Forward Anchor Pin - Early Models

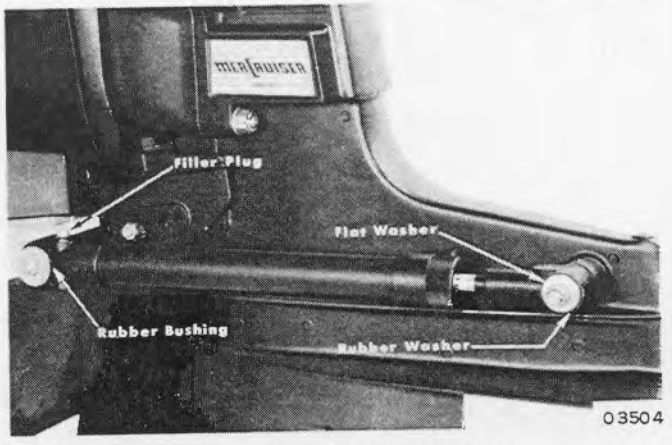
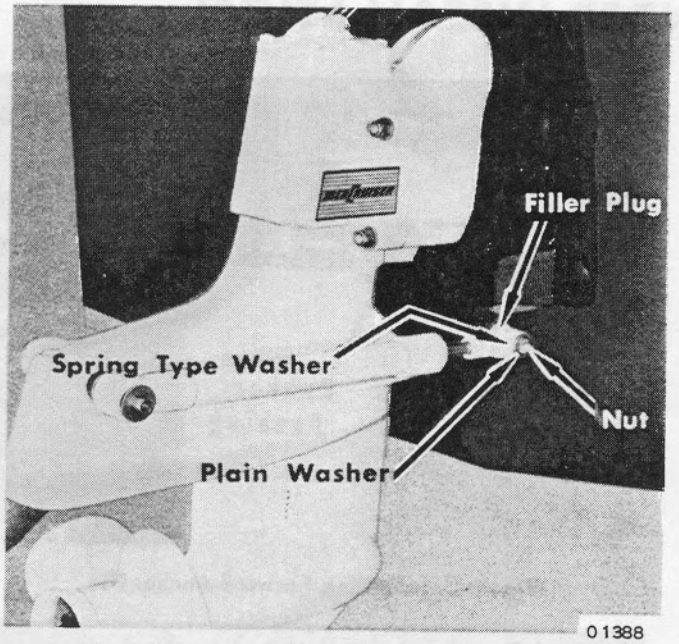


Figure 5. Cylinders Installed



4. Place cylinders in position on forward and aft anchor pins.

   NOTE: Cylinders must be installed with filler plug facing up. (Figures 5 or 6)

5. Place parts required on forward and aft anchor pins. (Figure 5 or 6)
6. Install nuts and tighten securely. (Figure 5 or 6)
7. This completes cylinder installation.

Figure 6. Cylinder Installed - Early Model

SECTION 2 - REMOVAL, INSTALLATION and ALIGNMENT

MERCRUISER

PART B - ALL MERCRUISER I TYPE STERN DRIVES

MERCURY MARINE

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MERCRUISER I ENGINE REMOVAL

IMPORTANT: The MerCruiser Stern Drive Unit is designed for use with MerCruiser marine 4-cylinder and 6-cylinder engines which have standard automotive engine rotation (counterclockwise when viewing engine flywheel from the rear). All drive units are right hand propeller rotation.

NOTE: Stern drive unit must be removed prior to engine removal, if engine can not be moved forward sufficiently to clear drive shaft. Stern drive removal procedure is the reverse of installation, following.

1. Disconnect battery cables from battery and remove instrument panel harness connector plug from engine harness receptacle.
2. Disconnect fuel line and throttle and shift control cables.

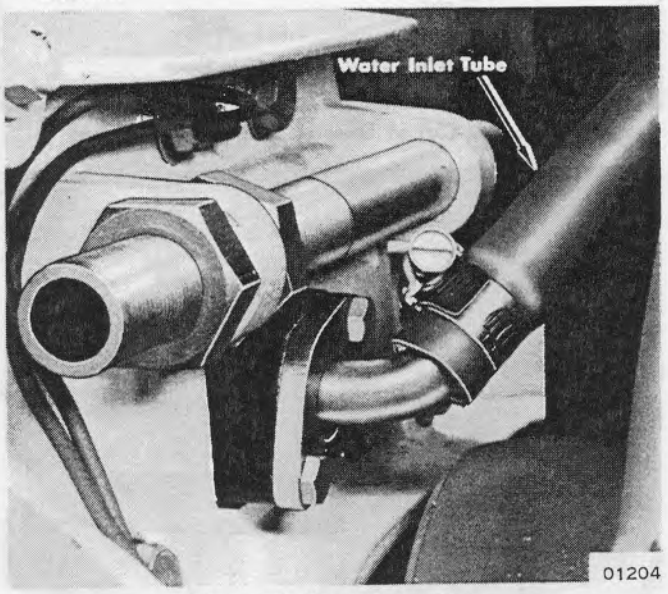

Figure 1. Water Inlet Tube

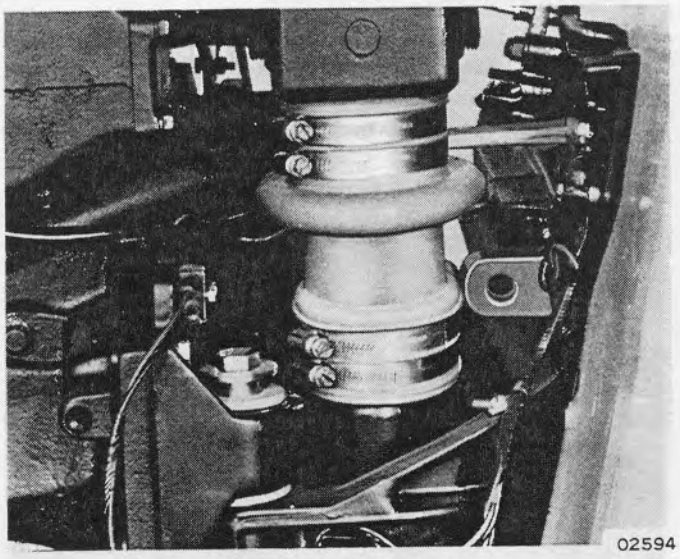

Figure 2. Exhaust Tube

3. Disconnect shift inter-lock switch wires, trim indicator sender wires and hydraulic pump motor wires from engine.
4. Remove water inlet tube and exhaust tubes. (Figures 1 and 2)
5. Support engine with a suitable sling thru lifting eyes on engine and remove front and rear engine mounting bolts.
6. Remove engine.

ENGINE INSTALLATION and ALIGNMENT

1. Support engine with lifting eyes on engine.

   NOTE: Lubricate coupling splines with New Multi-purpose Lubricant (C-92-49588).

2. Place following parts on top of inner transom plate engine mounting brackets: (Figure 3)
   a. Large fiber washer.
   b. Special split lockwasher inside diameter of large fiber washer.

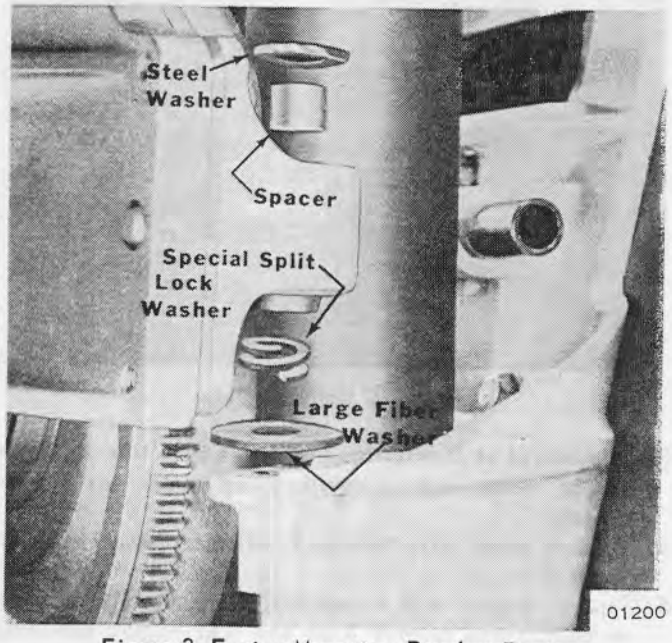

Figure 3. Engine Mounting Bracket Parts

CAUTION: To help overcome misalignment, made at time of engine installation, engine height on MerCruiser 120 (Serial No. 2050045 and up) and MerCruiser 160 (2051445 and up) have been lowered 3/32" (2.4mm) via narrow spacers above engine mounts in flywheel cover. To lower engine height on all model 110-140-150 and 120-160's (below Serial Nos. listed above), cut the special, double-wound spring lockwasher (B-13-33734) in half (same result as installing new spacers). (Figure 4) DO NOT CUT special lockwasher on Merc 120-160 engines above Serial Nos. listed.

3. Position engine over transom plate mounting brackets. Place hose clamps over rubber exhaust tube or bellows and position over manifold outlet. Tighten hose clamps securely. (Figure 4 or 5)
4. Place steel washers and spacers on mounting bolts and insert bolts down thru engine mounts, washers and mounting brackets. Thread elastic stop nuts on bolts. Do not tighten.
5. Adjust front mounting bracket by turning adjusting nuts until bracket rests firmly on mount location in boat to relieve hoist tension. (Figure 5)
6. Torque rear mounting bolts to 35-40 ft. lbs. (4.83-5.52mkg).

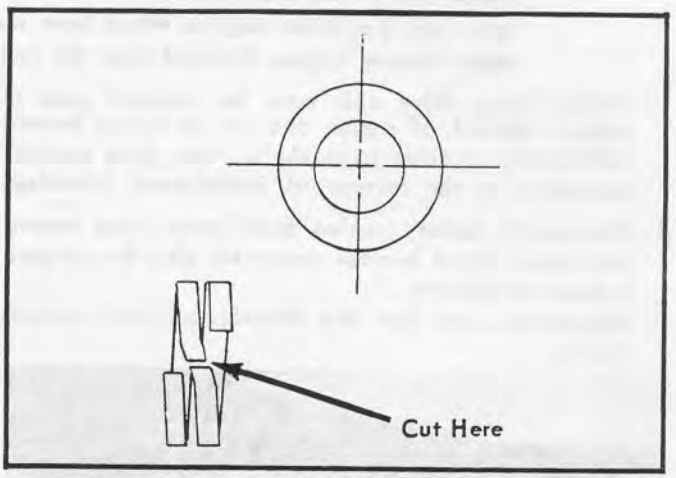

Figure 4. Cut of Special Spring Lockwasher

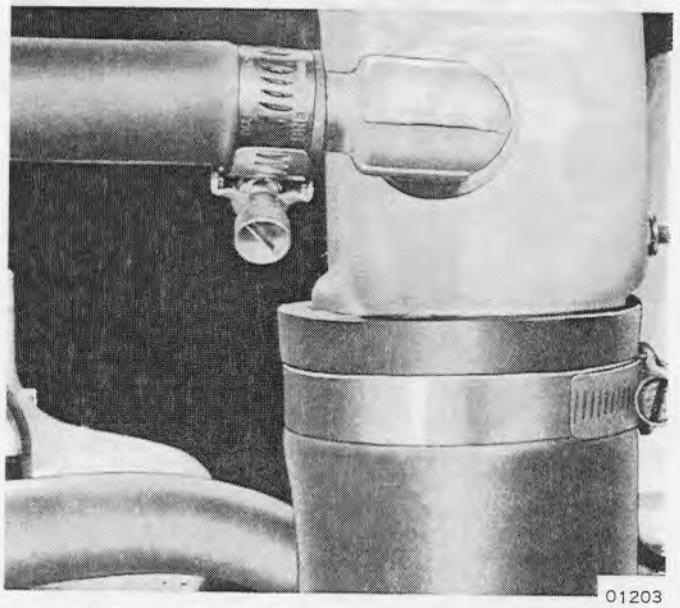

Figure 5. Installing Flexible Exhaust Tube

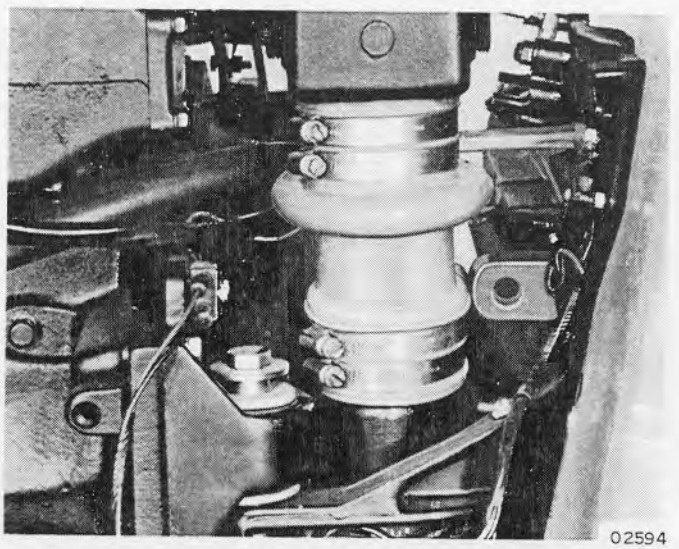

Figure 6. Installing Flexible Exhaust Tube Bellows

Figure 7. Installing Front Engine Mounting Bracket

7. Insert small diameter end of Alignment Shaft (C-91-48247 or C-91-57797A1) thru gimbal bearing. (Figure 8) Move gimbal bearing with alignment shaft to insert it into engine coupling spline, if necessary. If alignment shaft enters coupling freely with no pressure, alignment is correct. If not, loosen front mounting bracket adjusting nuts and thread either way to raise or lower front of engine until alignment shaft slides into engine coupling spline with no pressure.
8. After correct alignment shaft fit, tighten lower adjusting nuts securely. Recheck alignment shaft fit.
9. Secure mounting bracket to boat.
10. Place hose clamp over water inlet tube and place tube over copper inlet pipe. Fasten hose clamp securely. (Figure 9)

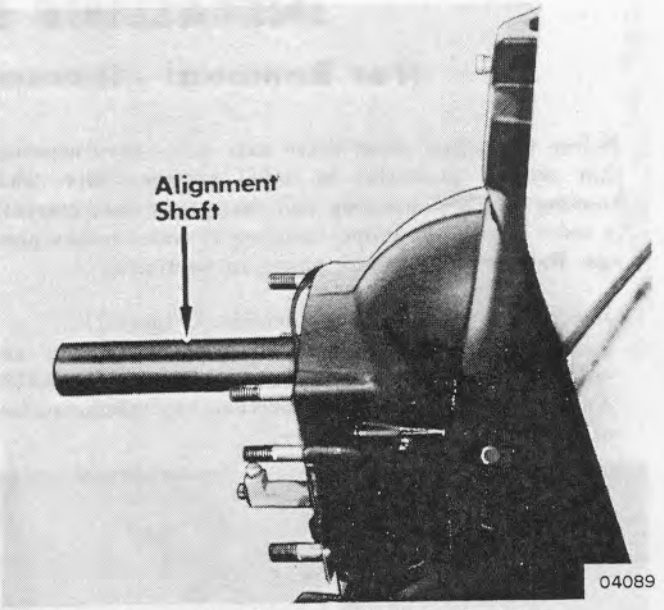

Figure 8. Alignment Shaft in Position

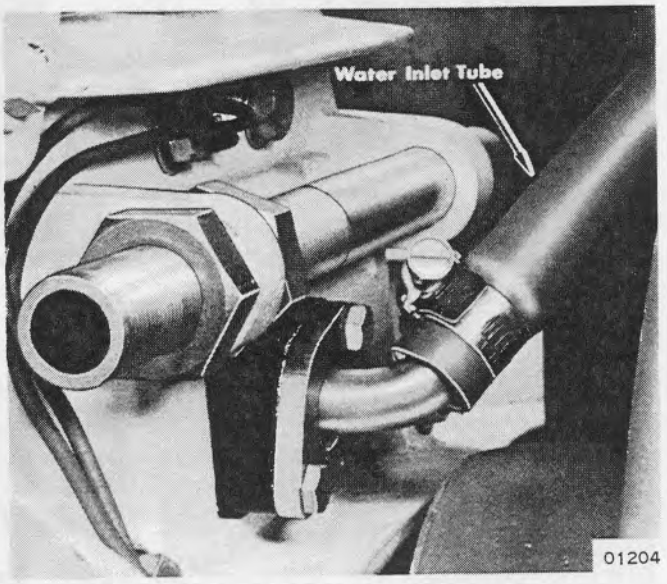

Figure 9. Installing Water Inlet Tube

INSTALLING STERN DRIVE UNIT

(For Removal - Reverse the Following Procedure)

Before installing stern drive unit, it is very important that correct gasket(s) be used between drive shaft housing and bell housing and that parts mate correctly in order to provide proper sealing of water intake passage. Refer to appropriate pages in Section 6.

1. Lubricate shifting slide assembly. (Figure 1)
2. Lubricate drive shaft housing pilot and drive shaft splines with New Multipurpose Lubricant (C-92-49588). Apply a light coating of lubricant to inside surfaces of bell housing bore. (Figure 2)

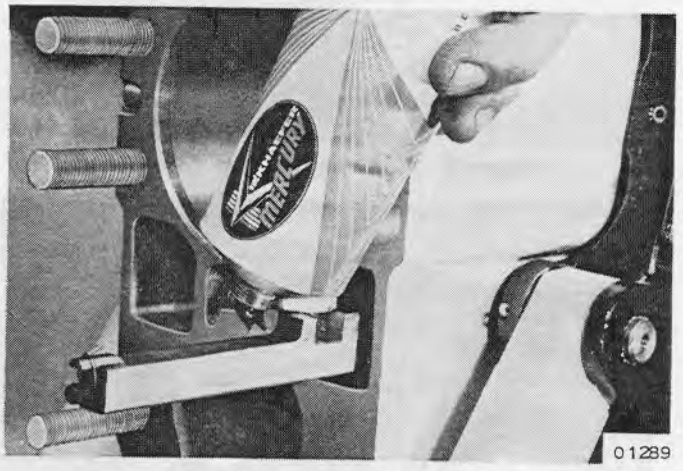

Figure 1. Lubricating Shifting Slide Assembly

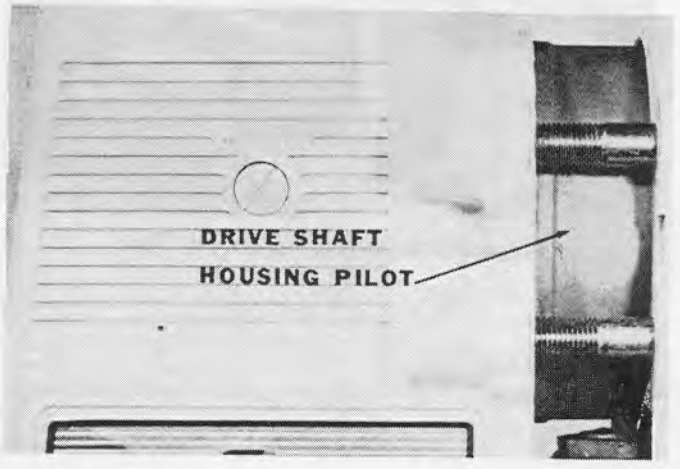

Figure 2. Drive Shaft Housing Lubrication and Installation

CAUTION: If locating slot of shift lever in bell housing and coupler of intermediate shift shaft in drive shaft housing are not aligned as described in Steps 3 and 4, bell housing and shift shaft couplers will be damaged when drive unit is installed.

3. Align shift lever coupler slot straight by moving shift lever to right. Lubricate slot and reverse lock roller with New Multipurpose Lubricant. (Figure 3)

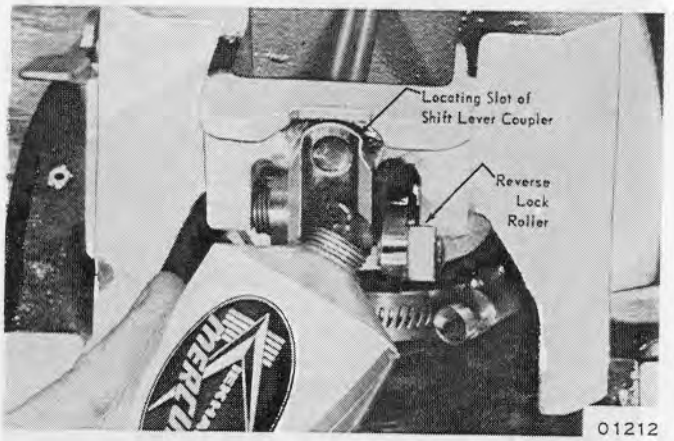

Figure 3. Lubricating Slot and Reverse Lock Roller

4. Align intermediate shift shaft coupler for straight entry into locating slot of shift lever while in forward gear. (Figure 4)

   NOTE: It may be necessary to rotate propeller shaft to align intermediate shift shaft coupling with upper shift shaft slot.

5. Lubricate coupler cam surface and lower roller with New Multipurpose Lubricant.
6. Position drive shaft housing gasket in place.

   NOTE: Place reverse lock hook release lever in "Lock" position on drive shaft housings so equipped.

7. Insert stern drive unit into bell housing bore. (Figure 2)
   a. Guide U-joint shaft splines thru gimbal bearing into drive coupling while guiding shift slide into opening in drive shaft housing.

      NOTE: Since fit between U-joint "O" rings and gimbal housing ball bearing is tight, coat "O" rings with New Multipurpose Lubricant.

   b. Be careful not to move shift slide assembly or coupler.
8. If drive shaft splines do not align with engine coupling splines, place propeller on shaft and rotate counterclockwise until drive unit can be pushed into position.

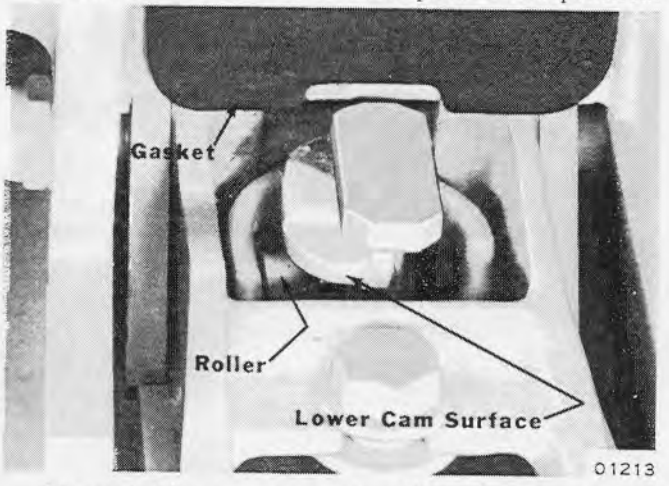

Figure 4. Aligning Intermediate Shift Shaft Coupler

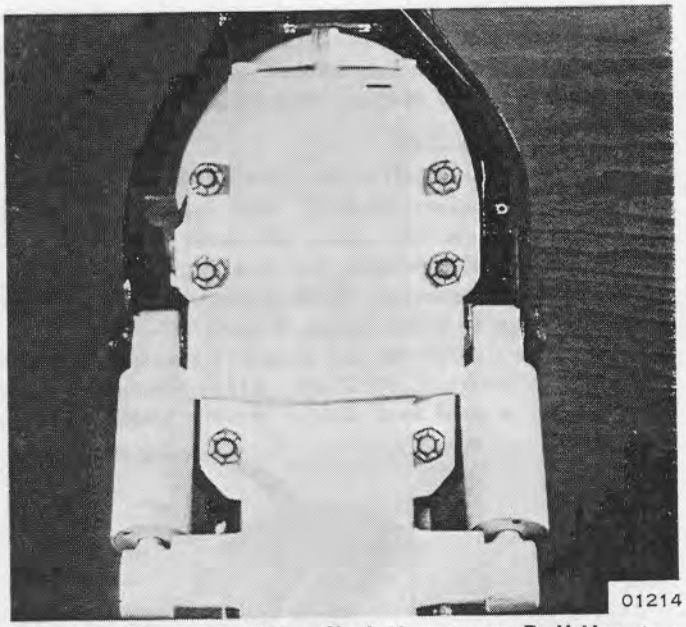

Figure 5. Fastening Drive Shaft Housing to Bell Housing

9. Fasten drive shaft housing with elastic stop nuts and flat washers and torque evenly to 50 ft. lbs. (6.9mkg). (Figure 5)

   NOTE: Refer to "Drive Shaft Housing to Bell Housing Combinations" in "Drive Systems" Section 6. For Units with Dyna-Shocks, place one washer on Dyna-Shock thru bolt and insert bolt thru right Dyna-Shock, drive shaft housing and left Dyna-Shock. (Figure 6) Place washer on bolt and thread on elastic stop nut. Tighten nut and back off ½-turn.

10. Check that drive unit tilt adjustment bolt is installed in gimbal ring. Nut on bolt should be tightened and backed-off approximately ½-turn to allow bolt to rotate freely.

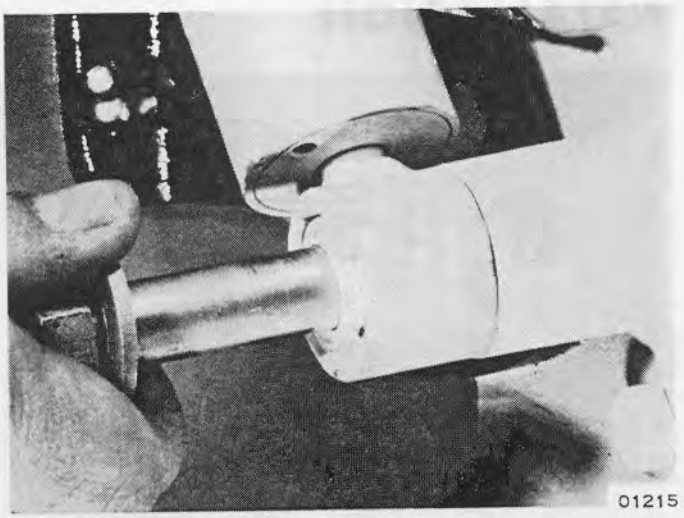

Figure 6. Installing Dyna-Shock Thru Bolt

CORRECT SEALING GASKET

MERCRUISER I

1. Early MerCruiser production used drive shaft housing as shown in Figure 7, bell housing and 2 gaskets as shown in Figure 8.

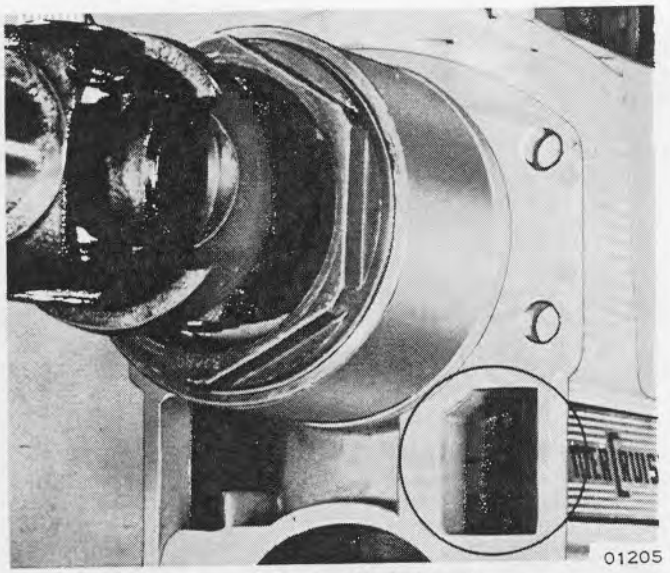

Figure 7. Drive Shaft Housing

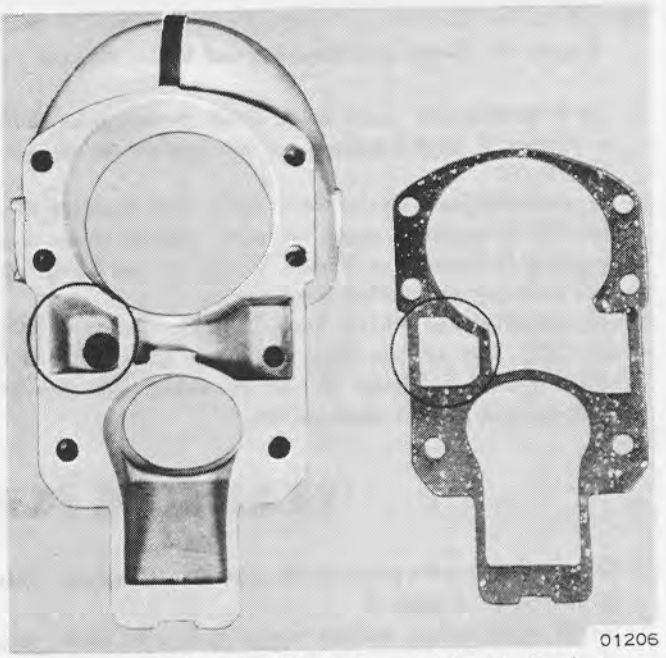

Figure 8. Left, Bell Housing and Right, Gasket

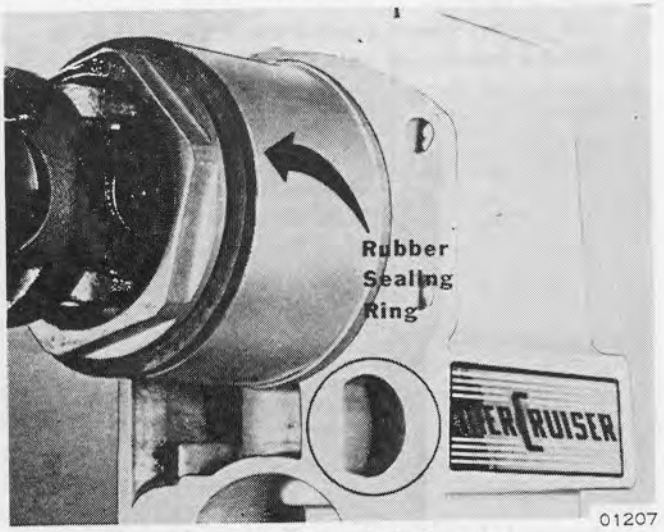

Figure 9. Drive Shaft Housing

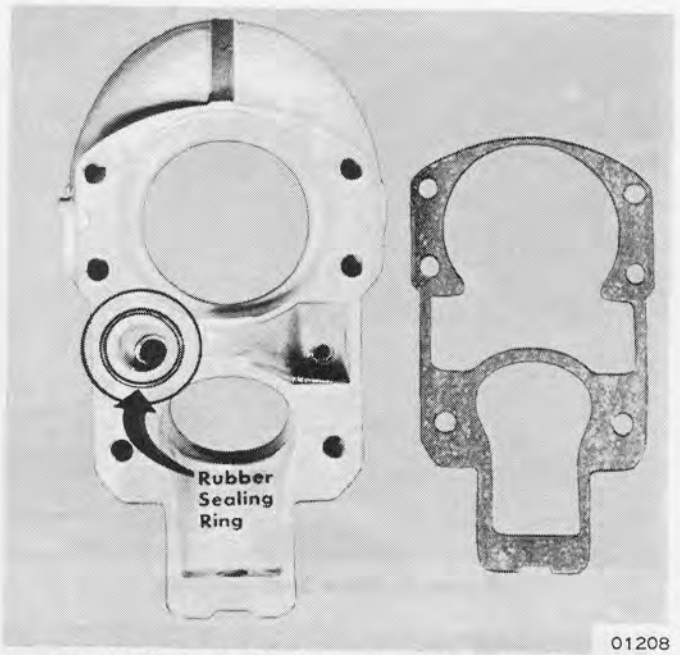

Figure 10. Left, Bell Housing and Right, Gasket

2. Later production used drive shaft housing as shown in Figure 9, bell housing and one gasket as shown in Figure 10.
3. On installations which have early bell housing (Figure 8), 2 gaskets must be used. Either drive shaft housing (Figure 7 or Figure 9) can be used with this bell housing and gasket combination.
4. On installations which have later bell housing (Figure 10), one gasket must be used. Only later drive shaft housing (Figure 9) can be used with this bell housing and gasket combination.
5. If drive unit has been installed previously and gaskets are compressed, new gaskets should be installed or leakage will occur. Use Gasket Adhesive (C-92-25234) to secure gaskets to drive shaft housing.

MERCRUISER IA-IB-IC

Do not attempt to install a MerCruiser I drive shaft housing on a MerCruiser IA-IB-IC bell housing. Although the bolt pattern is the same, the drive shaft will not align with the gimbal housing ball bearing.

1. Use Gasket Adhesive (C-92-25234) to secure rubber sealing rings to bell housing. (Figure 11)
2. Use gasket C-27-35996 and secure to bell housing with Gasket Adhesive (C-92-25234). Always replace gasket to assure a good seal and to prevent water leakage.

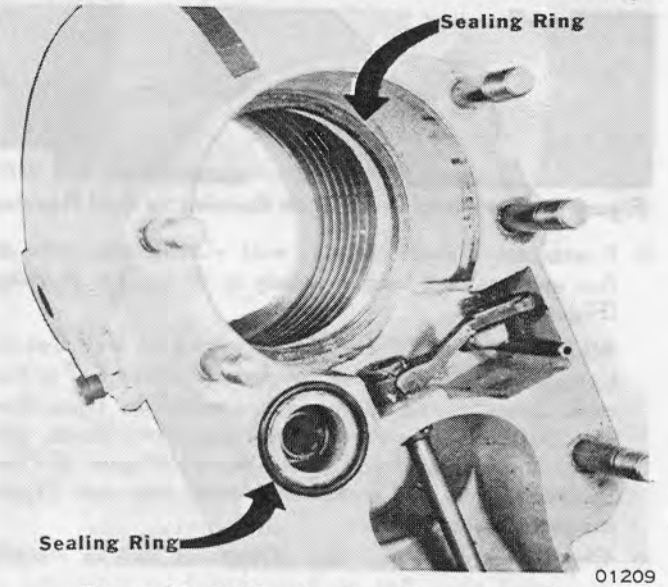

Figure 11. Rubber Sealing Rings Secured

TRANSOM PLATE INSTALLATION

1. Set gimbal housing assembly and inner transom plate in position. (Figure 1)
2. Insert shift cable, switch leads, hydraulic lines, etc, thru proper openings in transom and inner transom plate. (Figure 2)
3. Hold gimbal housing and inner transom plate in position and fasten with nuts and bolts. (Figure 1)

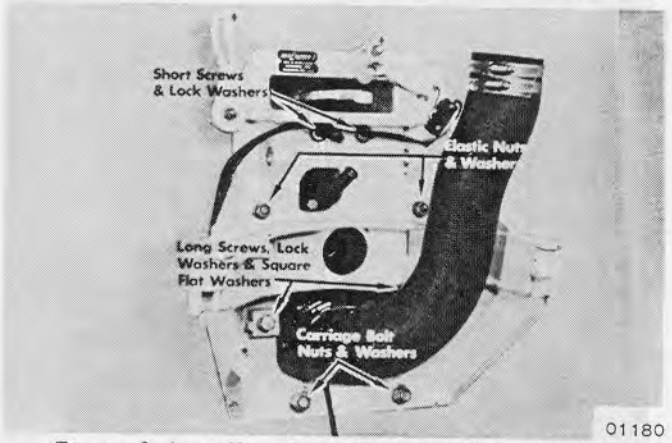

Figure 1. Installing Inner Transom Plate (Early)

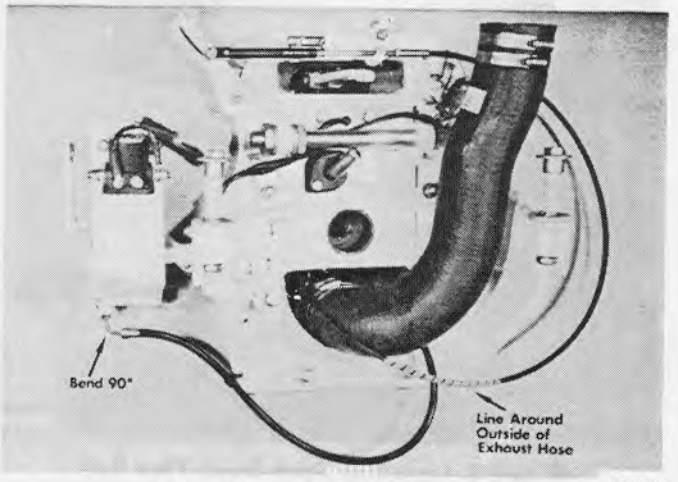

Figure 2. Late Routing of Hydraulic Line

NOTE: Do not attempt to drive cap screw thru transom, as threads in gimbal housing will be damaged.

4. Tighten screws and nuts evenly with 20-25 ft. lbs. (2.77-3.46mkg) torque.

HYDRAULIC PUMP HOSE ROUTING

INSTALLING HYDRAULIC HOSES

NOTE: New units are shipped with Power Trim hydraulic pump and trim sender installed.

1. Remove cap from fitting (located on end of black hydraulic hose) and remove threaded plug from pump. (Figure 3)

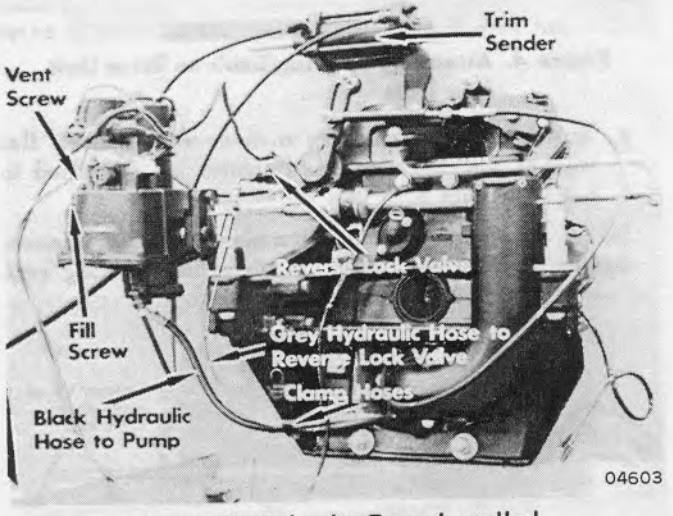

Figure 3. Hydraulic Pump Installed

2. Immediately connect hose to pump.
3. Remove cap from fitting (located on end of grey reverse lock valve hydraulic hose) and remove threaded plug from valve. (Figure 3) **DO NOT allow oil to run out of hose and pump.** Tighten fittings securely.
4. Clamp hydraulic hoses securely to transom plate at location shown in Figure 3. Use clamp and screw provided with transom plate.

IMPORTANT: Failure to comply with preceding Steps 1,2,3, and 4 may cause hydraulic hose to become damaged and render hydraulic system inoperative.

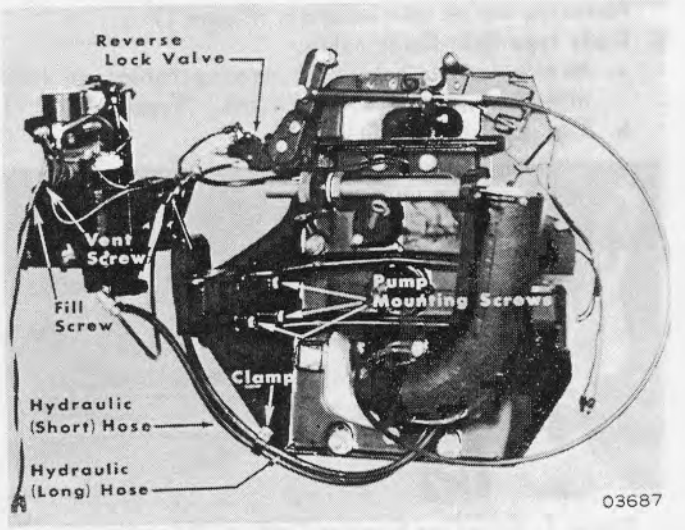

Figure 4. Hydraulic Hoses

5. Loosen pump reservoir screw. (Figure 3) Note that vent must be open for proper operation.
6. With unit down all the way in normal operating position, check oil level by removing "Fill" screw. If necessary, fill to bottom of threads with an SAE 20-20W specification MS automotive oil. Do not overfill.
7. Replace "Fill" screw.

MERCRUISER IA-IB-IC POWER TILT HYDRAULIC HOSE

To prevent damage to hydraulic line from engine coupling, the line is routed around outside of exhaust hose, rather than across top of exhaust hose. (Figure 3) This can be completed by loosening hydraulic coupling at the transom and repositioning as shown in Figure 4. Hydraulic line connector at hydraulic pump should be bent 90° to allow sufficient slack for hydraulic line.

RIDE-GUIDE STEERING CABLE ATTACHMENTS

1. Insert cable end thru tube and thread large hand-type fastening nut on tube securely. (Figure 1)
2. Early type Ride-Guide cable
   a. Attach coupler halves to steering cable and link with flat washer and lock nut. (Figure 1 or 2)
   b. Tighten nut securely.

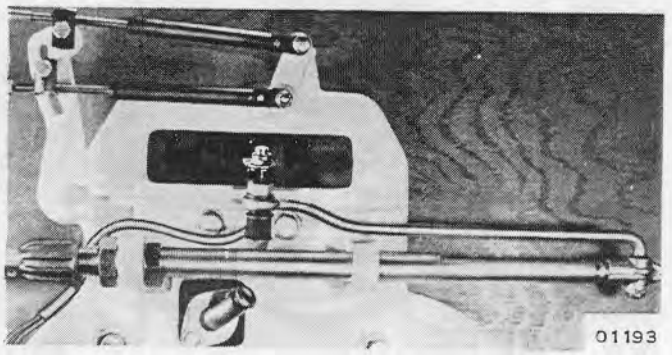

Figure 1. Attaching Steering Cable to Drive Unit from Right (Early Model)

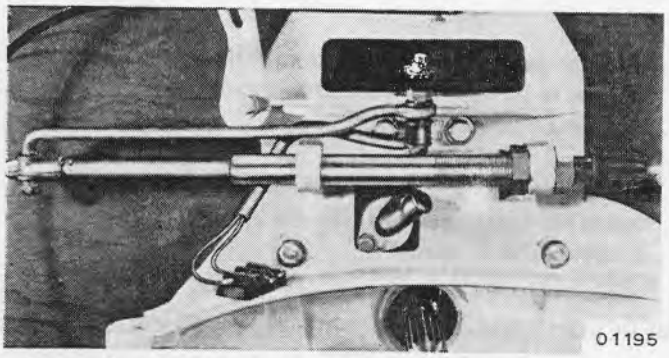

Figure 2. Attaching Steering Cable to Drive Unit from Left (Early Model)

3. Late type Ride-Guide cable
   a. Assemble spacers and cable on steering link rod. (Figure 3)
   b. Tighten nut securely, then back off ¼-turn (Figure 4) (or torque nut, Figure 5, to 12 ft. lbs. [1.7mkg]).

NOTE: Spacers are in plastic bag in cable carton.

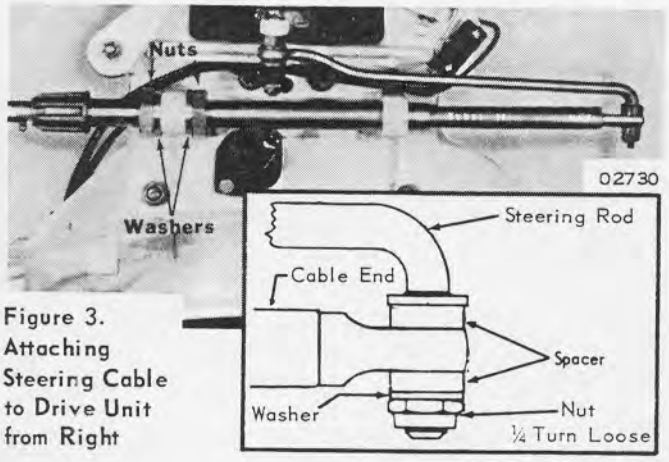

Figure 3. Attaching Steering Cable to Drive Unit from Right

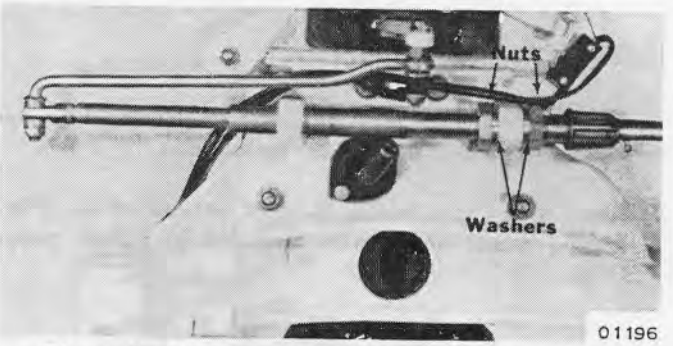

Figure 4. Attaching Steering Cable to Drive Unit from Left

c. Attach steering link rod to lever with spacer, flat washer and lock nut and tighten as specified in box of Figure 5.

NOTE: If steering lever has a special plastic sleeve, tighten no more than 50-60 in. lbs. (8.88-10.65kg/cm).

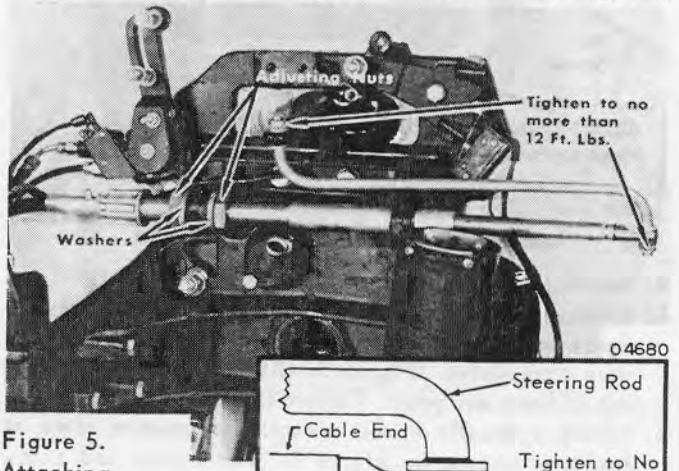

Figure 5. Attaching Steering Cable to Drive Unit from Right

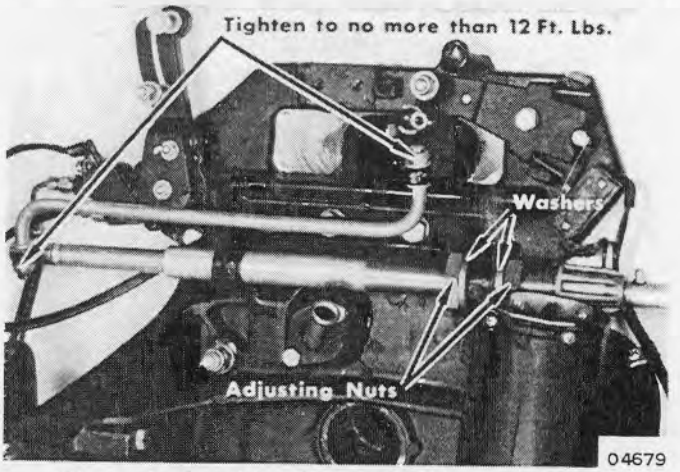

Figure 6. Attaching Steering Cable to Drive Unit from Left

ADJUSTING STEERING

Refer to Section 7, Part B, for steering adjustment.

ATTACHING THROTTLE CABLE - 4 and 6-CYL. ENGINES

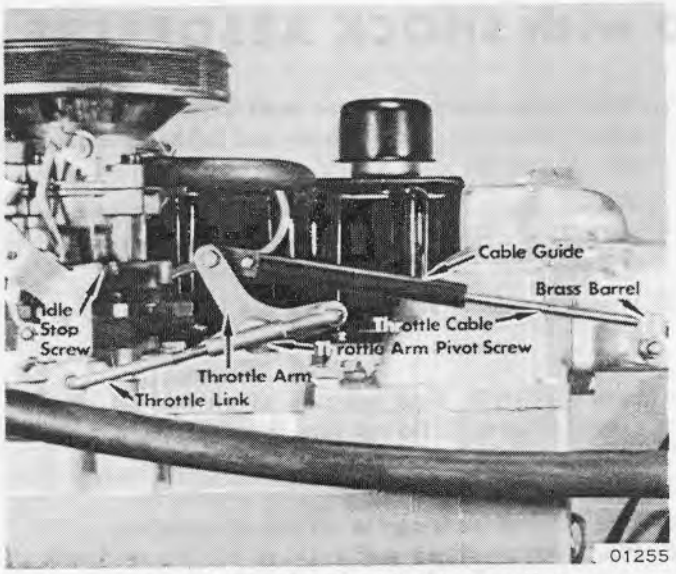

Figure 1. Throttle Control Cable Installed - Early 4-Cylinder Engine

1. Place remote control in neutral gear.
2. Fasten cable end guide to throttle lever arm. (Figures 1-thru-6)
3. Grasp throttle cable behind brass barrel and push cable toward throttle lever. Adjust barrel to align with anchor stud. Fasten barrel to stud.
4. Check that throttle valves are fully open when remote control is in full forward position. Return control to neutral gear and check for idle stop screw against stop.

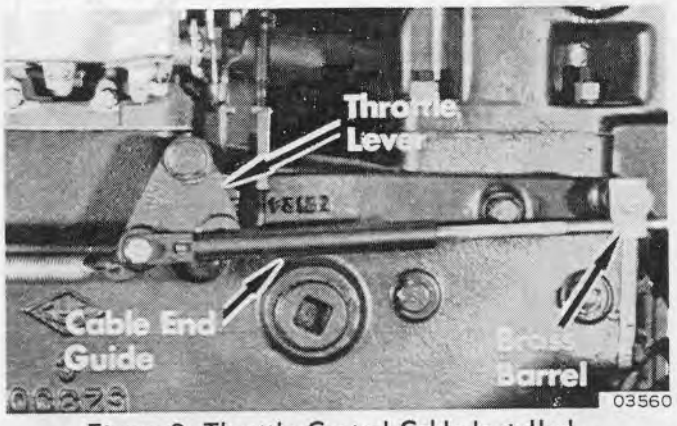

Figure 2. Throttle Control Cable Installed - Later 4-Cylinder Engine

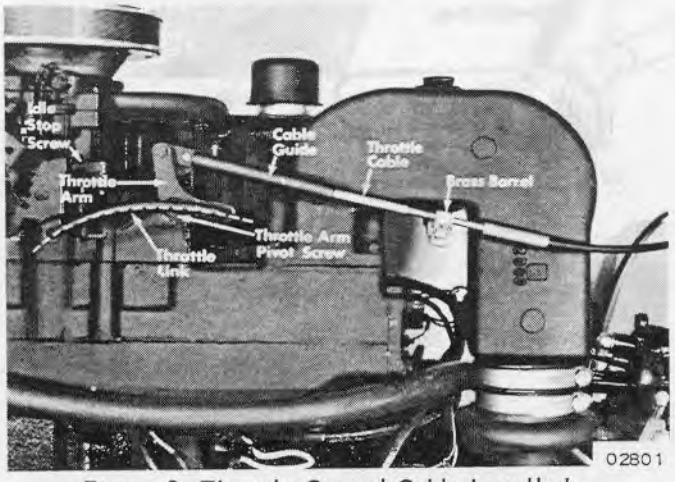

Figure 3. Throttle Control Cable Installed - 4-Cylinder "140" Engine

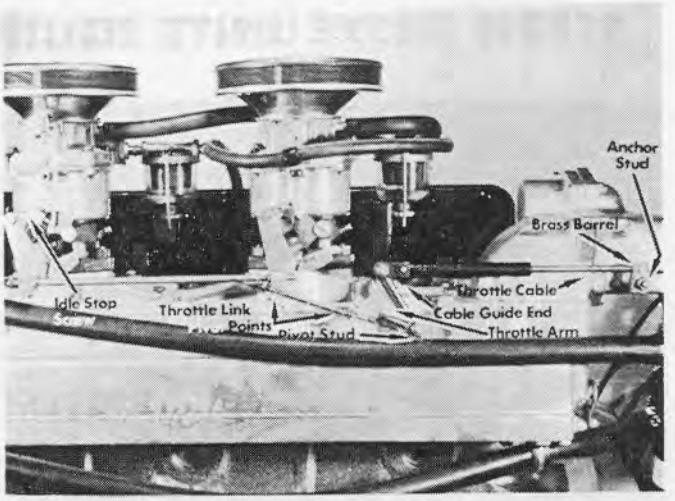

Figure 4. Throttle Control Cable Installed - 6-Cylinder Engine with Dual Carburetors

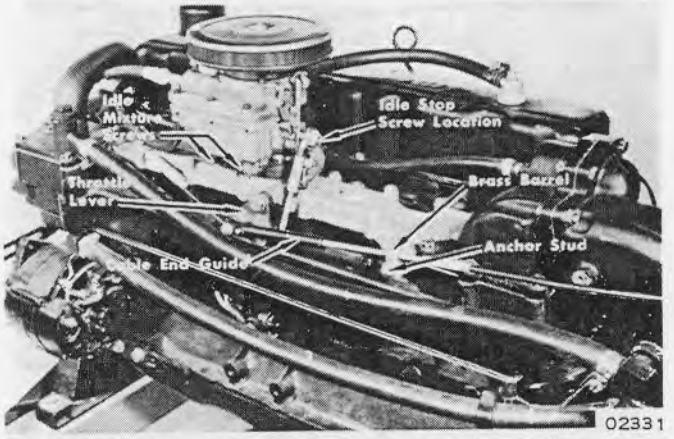

Figure 5. Throttle Control Cable Installed with Conversion Kit (Dual and Single Carburetion)

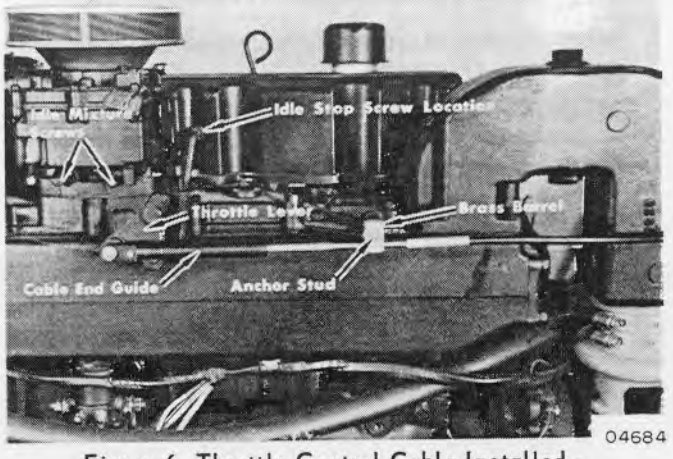

Figure 6. Throttle Control Cable Installed - 6-Cylinder Engine

INSTALLING HYDRAULIC CYLINDERS
STERN DRIVE UNITS EQUIPPED with SHOCK ABSORBERS

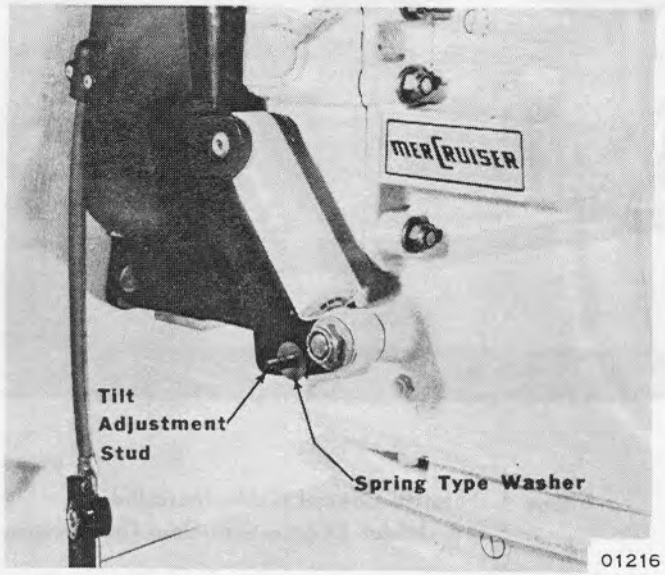

Figure 1. Tilt Adjustment Stud Installed

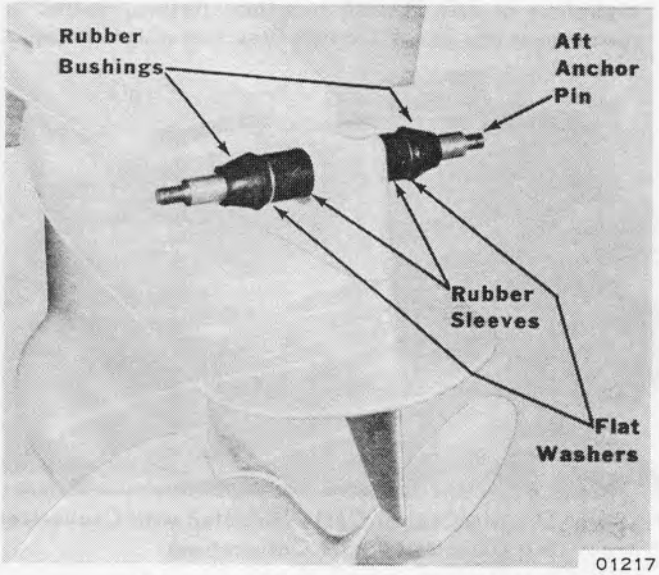

Figure 2. Aft Anchor Pin Installed

1. Insert tilt adjustment stud thru desired set of holes in gimbal ring. (Figure 1)

   NOTE: Place one spring-type washer on tilt pin stud on each side of gimbal ring. Dished side of washers must be away from gimbal ring.

2. Insert aft anchor pin in drive shaft housing and assemble rubber sleeves, flat washers and rubber bushings on pin. (Figure 2)

   NOTE: Apply a thin coat of New Multipurpose Lubricant (C-92-49588) on rubber bushings when installing hydraulic tilt cylinders. (Figure 2)

3. Position tilt cylinders on tilt pin stud and aft anchor pin.

   IMPORTANT: Note position of aft end of cylinders. (Figure 3) Do not turn outer portion of cylinders, as this will cause internal damage.

4. Place rubber bushings in aft end of cylinder.
5. Place flat washers and nuts on tilt pin stud and aft anchor pin and tighten securely. (Figure 3)

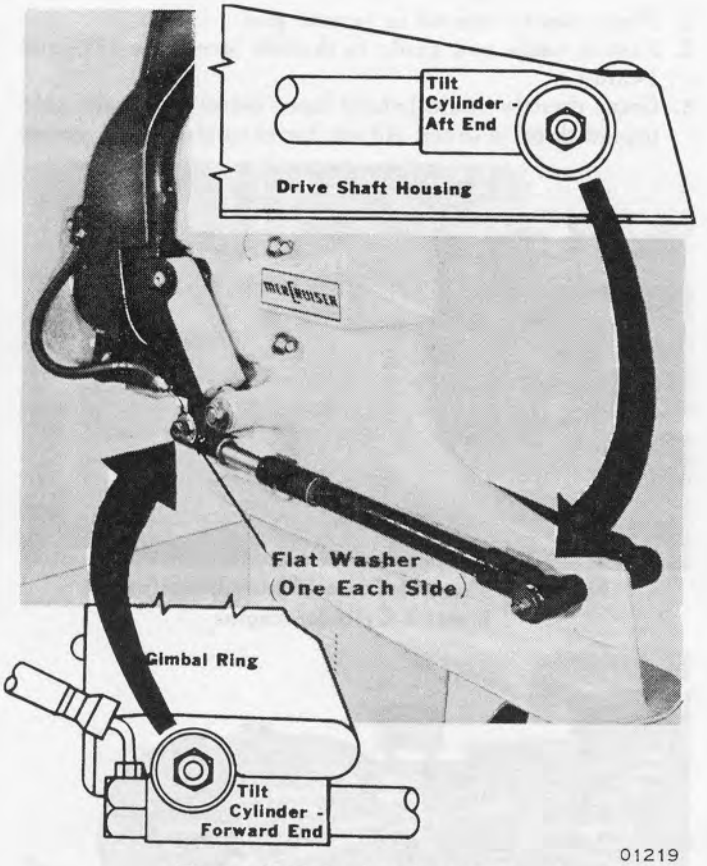

Figure 3. Cylinders Installed

INSTALLING TILT or TRIM COMBINATION

1. Insert tilt adjustment stud thru desired location in gimbal ring (Figure 4) which will place anti-cavitation plate parallel with boat bottom on those models so equipped. It may be necessary to change this position after initial test run, depending upon riding characteristics of boat.
2. Insert forward anchor pin in gimbal ring. (Figure 4)
3. Place flat washer and rubber bushing and spiral spring on each side of forward anchor pin.

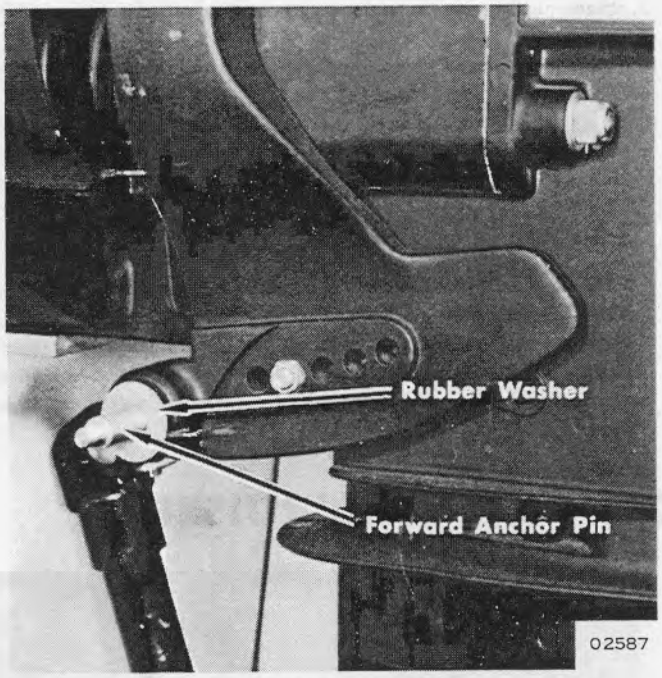

Figure 4. Tilt Adjustment Stud Installed

3. Install aft anchor pin and large washer, rubber bushing and spiral spring on each side of aft anchor pin. Place rubber bushing an each side of aft anchor pin. (Figure 5)
4. Place cylinders in position on anchor pins.

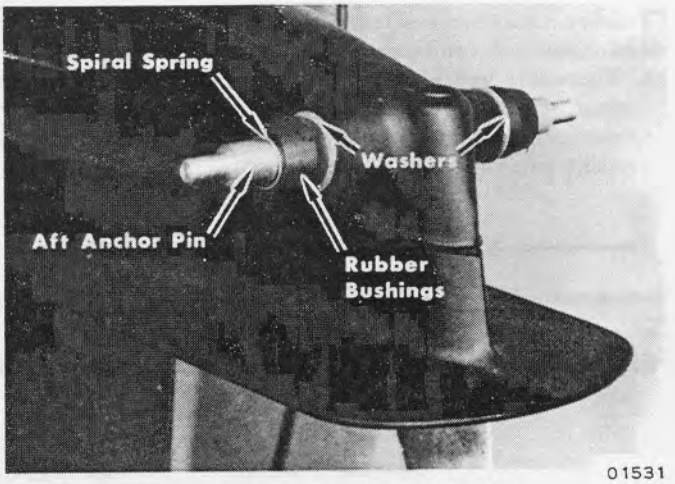

Figure 5. Aft Anchor Pin Installed

NOTE: Be sure that one spiral spring is installed between rubber bushings on each pin. (Figure 5)

6. Place rubber bushings in forward and aft end of each cylinder.
7. Place flat washer on each end of both anchor pins, install nuts and tighten securely. (Figure 6)

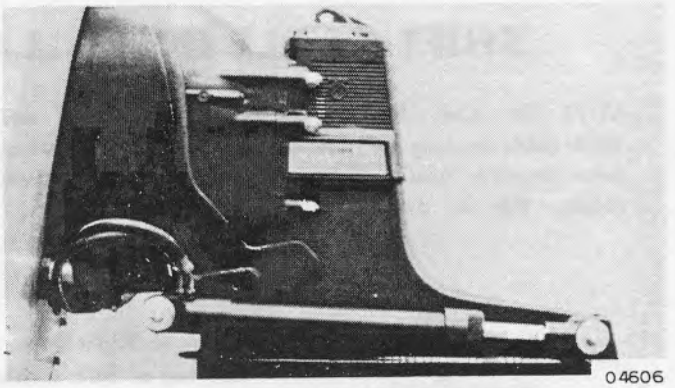

Figure 6. Cylinder Installed

SHIFT CABLE DIMENSIONS - ALL MERCRUISER I

To obtain maximum adjustability on remote control shift cable, check the following dimensions:

1. With cable end guide removed and unit in full forward gear, inner core wire of drive unit shift cable on early units must extend exactly 1-3/8" (3.5cm) from end of cable guide insert. (Figure 1)

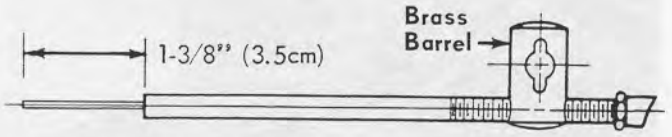

Figure 1. Solid Inner Core Wire Extension Stern Drive Unit Shift Cable - Early Style

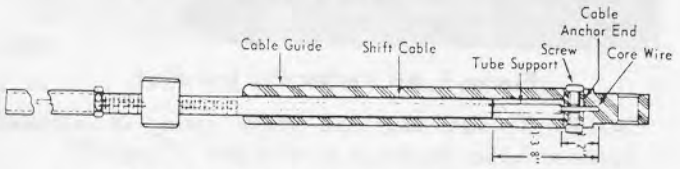

Figure 2. Support Tube and Core Wire

Later unit shift cables require installation of support tube on shift cable inner core wire (standard). (Figure 2)

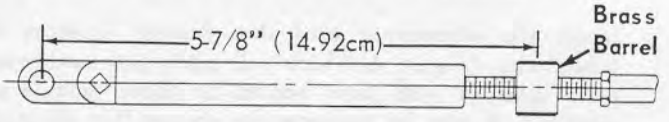

Figure 3. Centerline to Centerline 5-7/8" - Late Style

Slide support tube over core wire so that ½" (12.7mm) of core wire is shown. It is secured to core wire by crimping.

2. Slide cable end guide over end of cable thru cable anchor.
3. Snug one anchor screw and tighten the other to secure core wire. (Figure 2)
4. With cable end guide installed and unit in full forward gear, distance from centerline of brass barrel to centerline of cable end guide mounting hole must be exactly 5-7/8" (14.92cm). (Figure 3) Readjust brass barrel to achieve this dimension.

NOTE: Early MerCruiser I units have brass barrel on shift cable secured to transom plate with a spacer, washer and elastic stop nut. (Figure 1) On late MerCruiser I units, brass barrel of shift cable fits into recess of transom plate and is secured with a cotter pin. (Figure 3)

SHIFT CABLE INSTALLATION - ALL MERCRUISER I

NOTE: On early MerCruiser production, drive unit shift cable routing was on starboard (RIGHT) side of inner transom plate. (Figure 4) On later production, routing was on port (LEFT) side. (Figure 5)

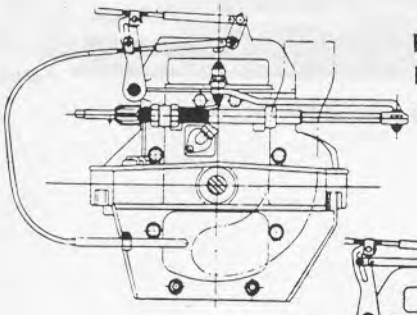

Figure 4. Right Side Routing of Shift Cable

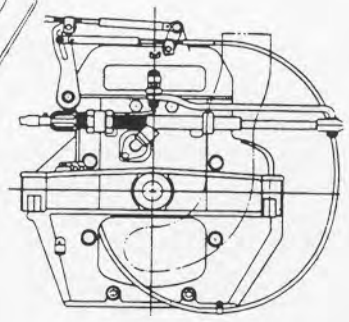

Figure 5. Left Side Routing of Shift Cable

RIGHT SIDE MOUNTED

1. Push nylon tube (from around shift cable) into recess in gimbal housing, then anchor tube and cable to inner transom plate with tab washer and flat head screw. (Figure 6)

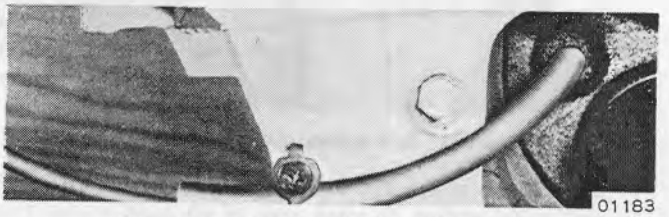

Figure 6. Attaching Shift Cable Tube

2. Set brass barrel on shift cable. See "Shift Cable Dimensions", preceding.
3. Fasten cable guide to mounting bracket stud, but do not tighten nut. (Figure 7)
4. Brass barrel mounting screw should be located at bottom of curved slot. Attach with thick washers which sandwich slot in shift lever. (Figure 7)

NOTE: Shift cables attach to same 2 points.

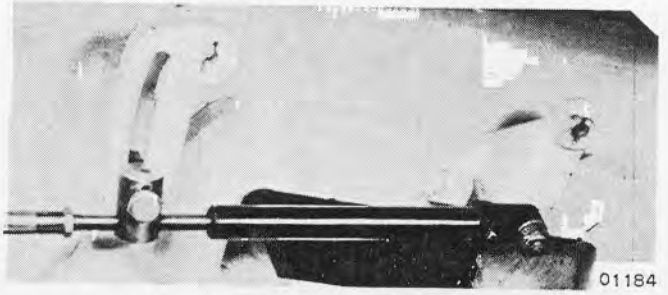

Figure 7. Fastening Cable Guide

LEFT SIDE MOUNTED

NOTE: Early MerCruiser I units have brass barrel on shift cable secured to transom plate with a spacer, washer and elastic stop nut. (Figure 8) On later units, brass barrel of shift cable fits into recess of transom plate and is secured with a cotter pin. (Figure 9)

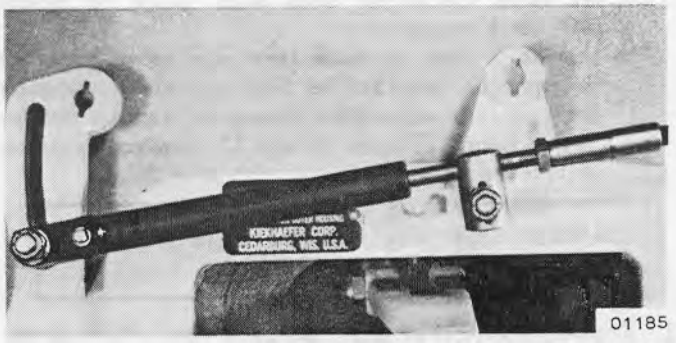

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Figure 8. Fastening Cable Guide - Early Models

1. Anchor shift cable to inner transom plate with clamp and screw. (Figure 10)
2. Set brass brarrel on shift cable. See "Shift Dimensions" , preceding.
3. Fasten cable end guide to shift lever. Do not tighten nut securely, as end guide must pivot freely on mounting stud. (Figure 8)
4. Fasten brass barrel to transom plate.

NOTE: Shift cables attach to same 2 points.

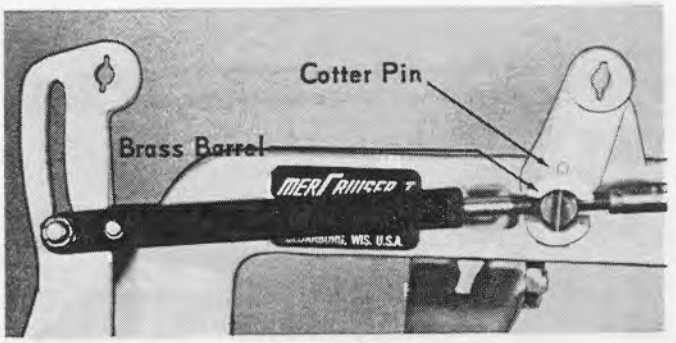

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Figure 9. Fastening Cable Guide - Late Models

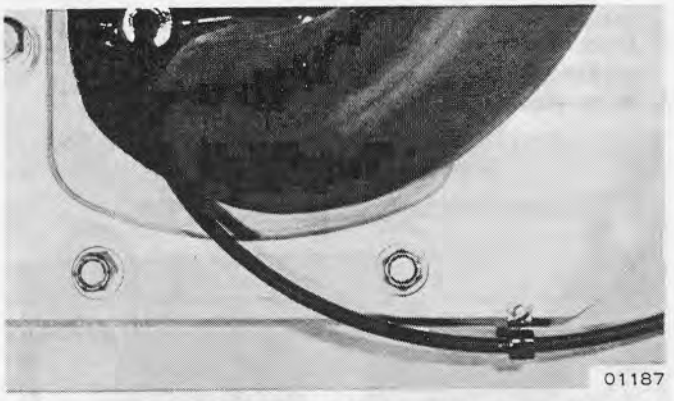
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Figure 10. Anchoring Shift Cable to Transom Plate

ATTACHING and ADJUSTING SHIFT CABLE

IMPORTANT: Install remote control and throttle and shift cables as outlined in instructions. Remote control shift cable may be installed in 2 ways, depending upon location of remote control station, right (starboard) side of boat, or left (port) side.

REMOTE CONTROL MOUNTED on RIGHT SIDE

1. With control cable attached in bottom of slot, move shift lever to right (when viewing lever from inside boat) as far as it will travel. (Figure 11) This shifts stern drive unit into forward gear. While shifting, turn propeller shaft counterclockwise until shaft stops, to ensure full clutch engagement.

NOTE: On E-Z Shift thru 160 models, place lockout screw thru cutout switch lever. (Figure 11) Some early MerCruiser drives have unit shift cable routed on left side of transom plate, as shown in Figure 5, preceding.

2. Move remote control handle to full forward position.
3. Anchor remote control shift cable end guide to transom plate anchor point. Pull outer conduit away from cable guide to eliminate slack in cable. Adjust brass barrel on remote control shift cable to align with mounting hole in shift lever. (Figure 12)

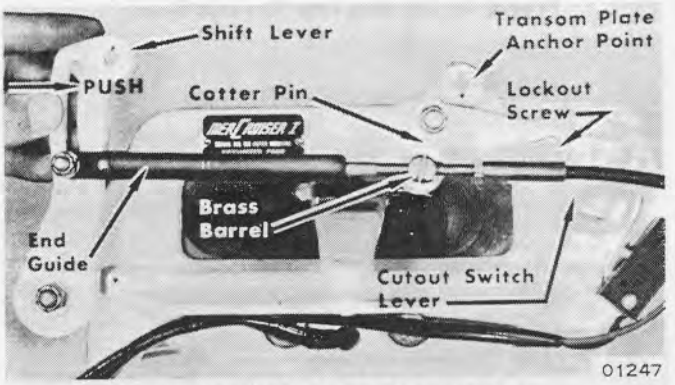

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Figure 11. Shifting into Forward Gear

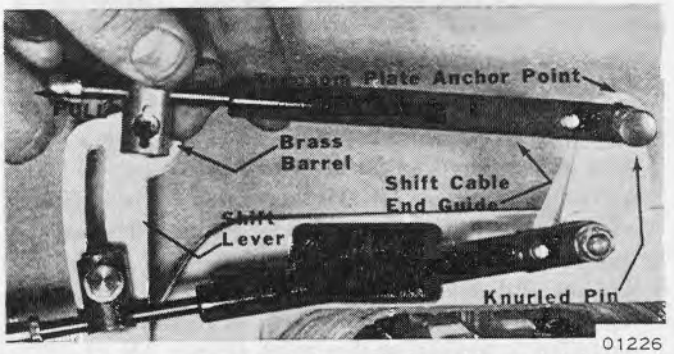

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Figure 12. Removing Slack from Shift Cable and Adjusting Brass Barrel

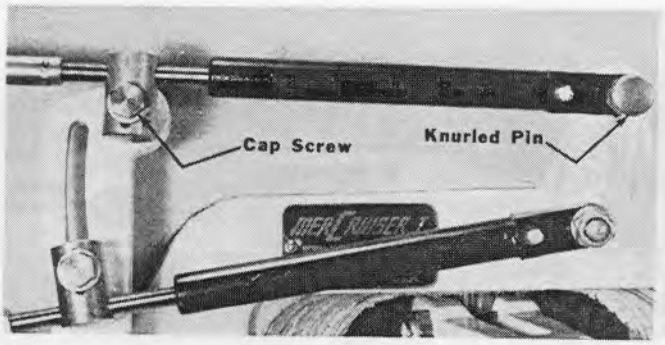

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Figure 13. Shift Cable Installed

4. Fasten brass barrel and spacer to shift lever. Tighten nut securely. (Figure 13)
5. Disconnect shift cable end guide from transom plate anchor point.
6. Move remote control handle to full reverse.

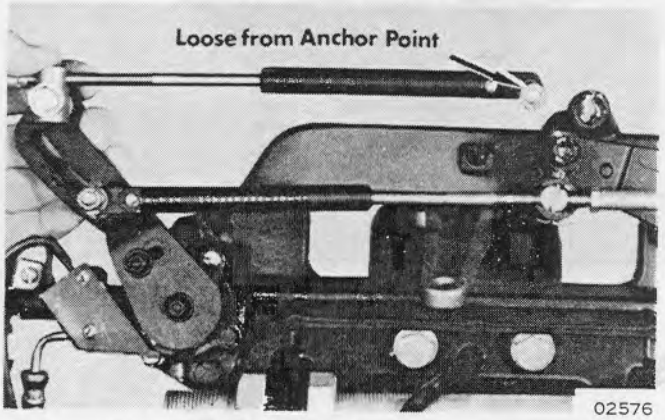

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Figure 14. Shifting into Reverse Gear

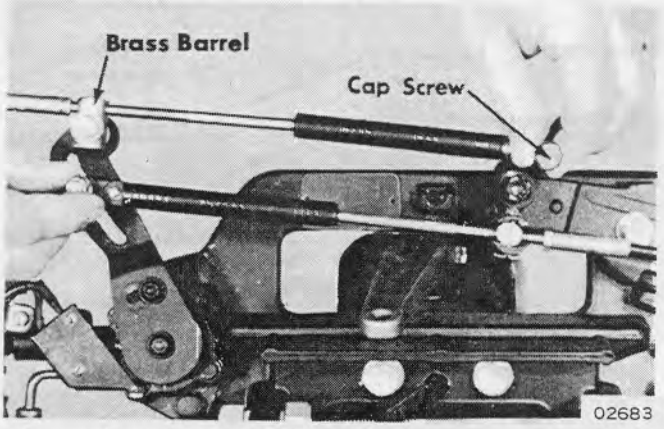

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Figure 15. Locating End Guide in Shift Lever Slot and Anchoring Shift Cable

7. Manually move shift lever to left (when viewing lever from inside boat) as far as it will go. (Figure 14) This shifts stern drive unit into reverse. While shifting, rotate propeller shaft clockwise until shaft stops, to ensure full clutch engagement.
8. Loosen and move end guide of stern drive shift cable up slot in shift lever until cable end guide can be re-installed to transom anchor point. (Figure 15)
9. Secure stern drive cable end guide to shift lever.

NOTE: Follow Steps 10 and 11, following, for models with Power Trim or E-Z Shift feature.

10. Reverse lock valve adjustment (Power Trim units only):
    a. Shift into full reverse. While shifting, rotate propeller shaft clockwise until shaft stops, to ensure full clutch engagement.
    b. Loosen 2 nuts on shift lever and move upper nut in direction required to line up raised triangular mark on cam with raised triangular mark on reverse valve cover. (Figures 16 and 17) Tighten 2 nuts on shift lever.

CAUTION: Unit may be locked in neutral if reverse lock valve is over-adjusted.

11. Remove screw that was attached thru shift cutout switch lever. (Figure 15)

This completes shift cable installation.

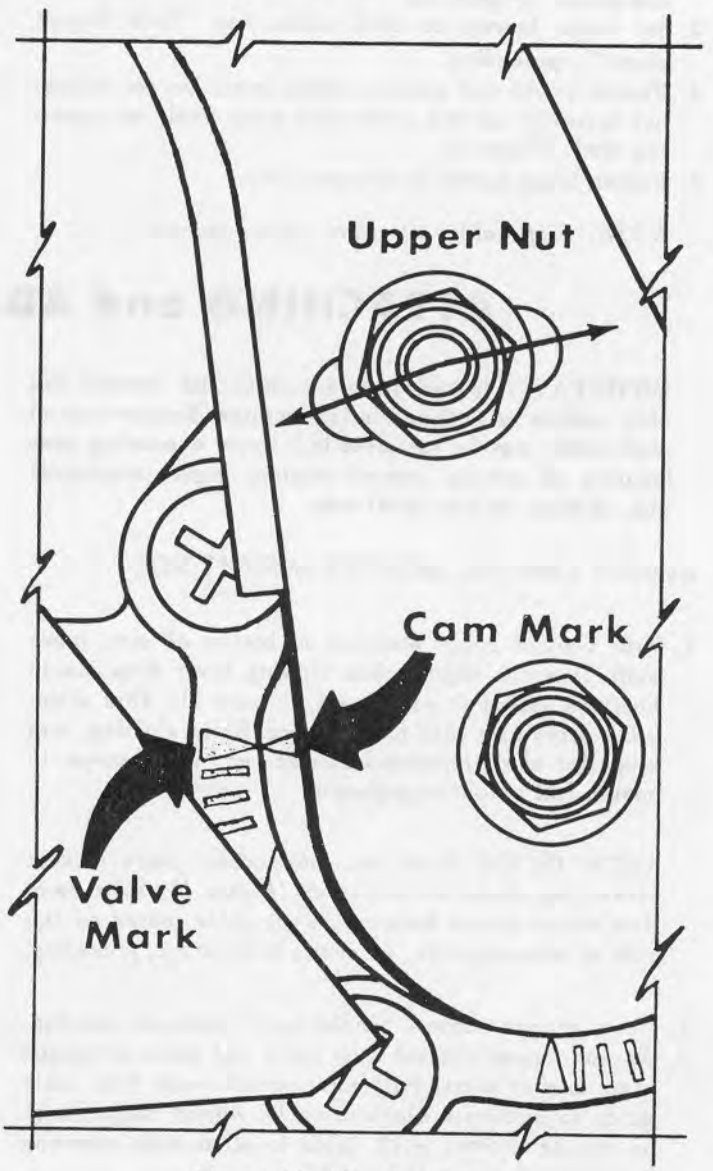

Figure 16. Aligning Marks

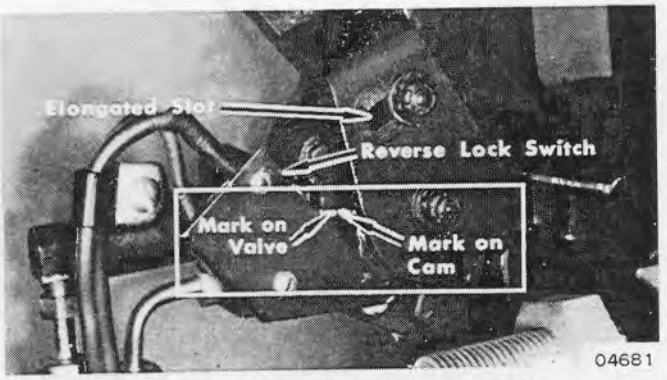

Figure 17. Adjusting Reverse Lock Valve

REMOTE CONTROL MOUNTED on LEFT SIDE

1. On E-Z Shift thru 160 models, place lockout screw thru cutout switch lever. (Figure 15)
2. With shift cable attached in bottom of slot, move shift lever to right (when viewing lever from inside boat) as far as it will go. (Figure 11) This shifts stern drive unit into forward. While shifting, turn propeller shaft counterclockwise until shaft stops, to ensure full clutch engagement.
3. Move remote control handle to full forward.
4. Anchor shift cable end guide to shift lever. (Figure 18) Pull outer conduit away from cable guide to eliminate slack in cable. Adjust brass barrel on shift cable to align with transom plate anchor point.
5. Fasten brass barrel with spacer to transom plate anchor point. Tighten nut securely. (Figure 19)

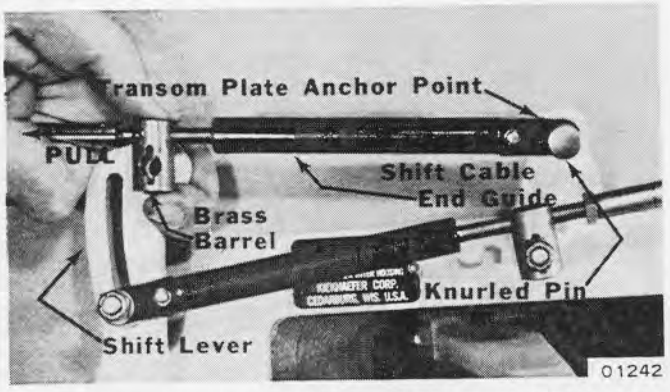

Figure 18. Removing Slack from Cable and Adjusting Brass Barrel

Figure 19. Shift Cable Installed

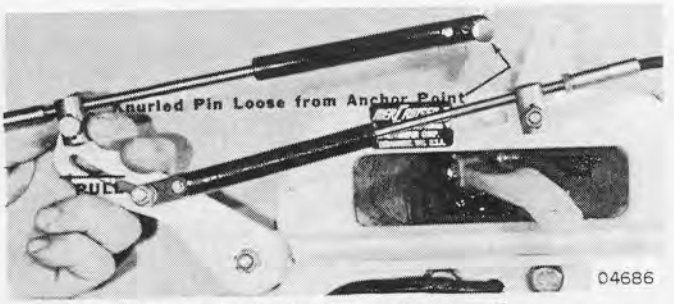

Figure 20. Shifting into Reverse Gear

6. Disconnect shift cable end guide from shift lever.
7. Move remote control handle to full reverse.
8. Manually move shift lever to left (when viewing lever from inside boat) as far as it will travel. (Figure 20) This shifts stern drive unit into reverse. While shifting, rotate propeller shaft clockwise until shaft stops, to ensure full clutch engagement.
9. Loosen and move end guide of stern drive shift cable up slot in shift lever until cable end guide can be re-installed on shift lever. (Figure 21)
10. Securely tighten nut on stud which fastens stern drive cable end guide to shift lever.

    NOTE: Models with Power Trim or E-Z Shift, complete Steps 11 and 12, following.

11. Reverse lock valve adjustment (Power Trim models only):
    a. Shift into full reverse. While shifting, rotate propeller shaft clockwise until shaft stops, to ensure full clutch engagement.

Figure 21. Locating End Guide in Shift Lever Slot and Anchoring Shift Cable

    b. Loosen 2 nuts on shift lever and move upper nut in direction required to line up raised triangular mark on cam with raised triangular mark on reverse valve cover. (Figures 16 and 17) Tighten 2 nuts on shift lever.

> CAUTION: Unit may be locked in neutral if reverse lock valve is over-adjusted.

12. Remove screw that was attached thru shift cutout switch lever. (Figure 20)

This completes shift cable installation.

SECTION 2 - REMOVAL, INSTALLATION and ALIGNMENT

MERCRUISER

PART C - MERCRUISER II STERN DRIVE (Non-Transom Mounted)

MERCURY MARINE

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MERCRUISER II ENGINE REMOVAL
(Non-Transom Mounted Type)

IMPORTANT: Stern drive unit must be removed prior to engine removal, if engine can not be moved forward sufficiently to clear drive shaft. Stern drive removal procedure is the reverse of installation, following.

1. Disconnect battery cables from battery and remove instrument panel harness connector plug from engine harness receptacle.
2. Disconnect fuel line and throttle and shift control cables.
3. Disconnect reverse lock switch, trim indicator switch wires and hydraulic pump motor wires from engine.
4. Remove water inlet tube and exhaust tubes.
5. Support engine with a suitable sling thru lifting eyes on engine and remove front and rear engine mounting bolts.
6. Remove engine.

ENGINE INSTALLATION and ALIGNMENT

IMPORTANT: It is necessary that the transom plates be installed BEFORE PROCEEDING with "Engine Installation". Refer to MerCruiser Stern Drive Installation, Following.

1. Lift engine with overhead hoist, using suitable sling and lifting eyes on engine.
2. Place engine in position but do not fasten mounting plates to boat stringers.
3. Position small tool plate of Engine Alignment Tool (C-91-31620A3) in bore of outer transom plate at engine end. Turn expander screw in tool plate to hold it in position. (Figure 1)

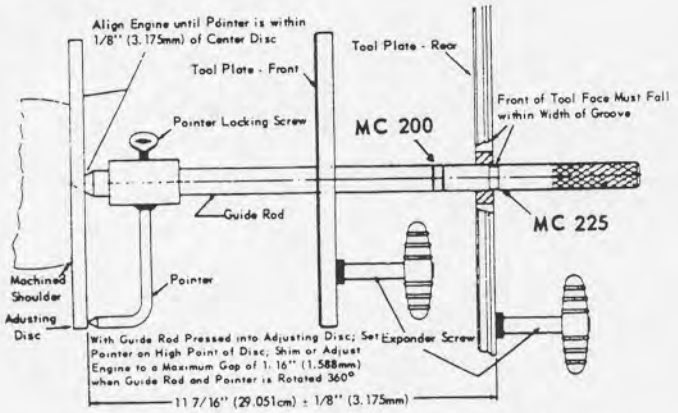

Figure 1. Alignment Tool C-91-31620A3

4. Set large tool plate in outer transom plate bore with shoulder of tool plate firmly against outer transom plate. Turn expander screw in tool plate to hold it in position.
5. Insert guide rod (pointed end) thru centers of tool plates and insert pointer on guide rod. (Figure 1)
6. Place adjusting disc on machined shoulder of engine coupling.
7. Engine mounts are adjustable to aid in obtaining correct engine alignment as outlined in Paragraphs 8-9-10-11, following. Mount adjusting points are as follows:

   Front and Rear Mounts (Figures 2 and 3)

   a. To raise or lower front or rear of engine, turn adjusting screw "A" clockwise to raise engine or counterclockwise to lower engine.
   b. To move engine to the right or left, loosen screw and nut "B".
8. Position engine, as required, to place pointed end of guide rod within 1/8" (3.2mm) or less of center of adjusting disc. (Figure 1)

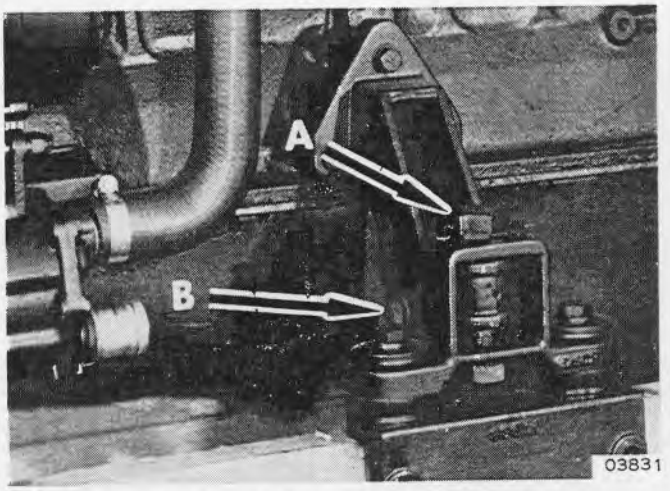

Figure 2. Front Engine Mount Adjustments

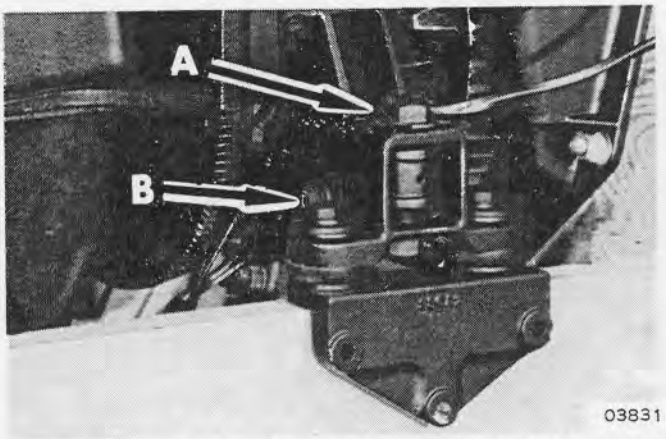

Figure 3. Rear Engine Mount Adjustments

9. Move engine forward or backward, as required, to place back surface of rear tool plate within width of proper groove in guide rod. (Figure 1)
10. With guide rod pressed into adjusting disc center, rotate guide rod and position pointer on highest point of adjusting disc. Secure pointer to guide rod by tightening pointer locking screw. (Figure 1)

11. Adjust engine mounts, as required, so that gap between pointer and adjusting disc is 1/16" (1.6mm) or less when pointer is rotated 360°. Adjusting disc may be painted with machinist's blueing so that areas, where pointer does not touch disc, may be seen easily.
12. Fasten mounting plates securely to boat stringers. Tighten screws and nuts ("B" in Figures 2-3-4) and bend tabs on tab washers over edge of mounts.
13. Recheck engine location and alignment (Steps 8-9-10-11) and make adjustments as necessary.
14. Remove alignment tool.

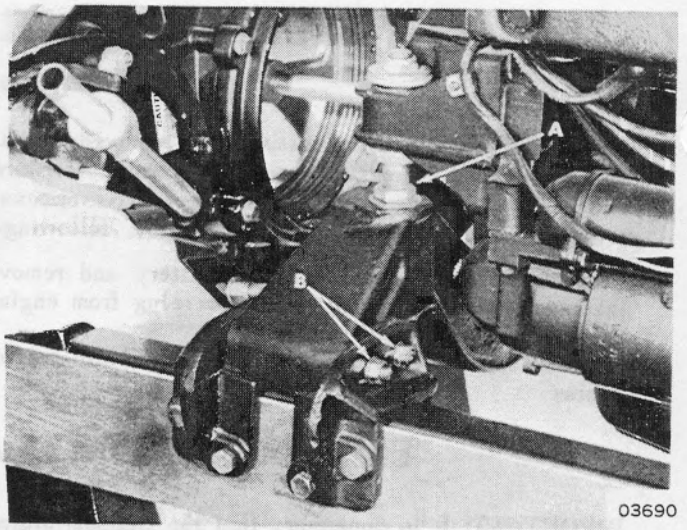

Figure 4. Rear Engine Mount Adjustments - Early

MERCRUISER II STERN DRIVE INSTALLATION

(For Removal - Reverse the Following Procedure)

1. Lubricate bore of outer transom plate and splined shaft of drive unit surfaces with New Multipurpose Quicksilver Lubricant (C-92-49588).
2. Insert tilt adjustment bolt thru one set of holes in gimbal ring. Thread nut on bolt and tighten. Back nut off 1/2-turn to allow bolt to rotate freely. Refer to "Tilt Bolt Adjustment" for correct adjustment when operating boat.
3. Insert MerCruiser shift cable and tilt-up switch cable thru opening in transom plates.
4. With unit rotated clockwise (as viewed from rear of boat) approximately 15° to clear stop screw, push unit into opening (Figure 1), aligning shaft spline with spline in coupler.

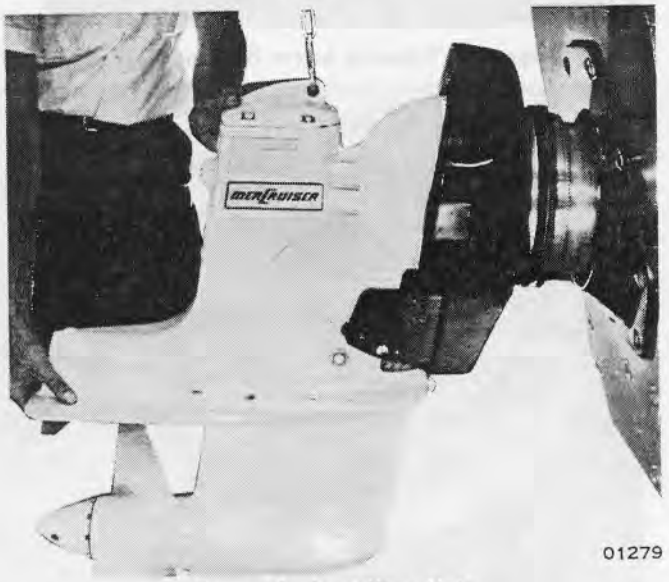

Figure 1. Installing Unit

5. Install crank on crank extension, press down and turn crank slowly clockwise. A slight movement of the unit inward indicates thread engagement. Now turn slowly counterclockwise to thread gimbal housing into clamp nut.

   NOTE: If, after engagement of threads, cranking is difficult, back off by turning crank in opposite direction. Do not force crank, as cross-threading may occur.

6. Crank until stop on gimbal housing is over the stop screw. (Figure 2)
7. Line up drive unit as close to perpendicular with boat bottom as possible.
8. Crank until clamp nut is tight.
9. While holding free end of latch actuating spring away from steering lever housing, assemble latch to housing with flat head nylock screw. (Figure 2) Turn in tightly and back out 1/4-turn. (Latch must pivot freely.) The free, formed end of latch actuating spring must be in contact with step in latch. (Figure 2)
10. Catch on clamp nut must be located approximately in the 1 o'clock position when viewing clamp nut from inside boat. Re-position in one set of the series of threaded holes in clamp nut, if necessary, to attain proper latch and catch engagement. If catch is not positioned correctly, teeth on gimbal housing and outer transom plate will be meshed when catch engages latch and unit cannot be rotated to the "Up" position.
11. Loosen 6 clamp nut cover mounting screws and rotate cover until latch seats firmly in notch. (Figure 2)

    NOTE: Latch must prohibit clockwise rotation of clamp nut cover.

12. Tighten 6 cover mounting screws.
13. Adjust stop screw against stop on steering lever housing.
14. Press down on crank and turn clockwise to rotate unit up for check.
15. After cranking unit down to running position, crank about 25 more turns until firmly locked.

    NOTE: If stern drive unit is not locked in operating position, and single lever remote control is not in neutral position, circuit from starter switch to starter is open, and starter will not operate.

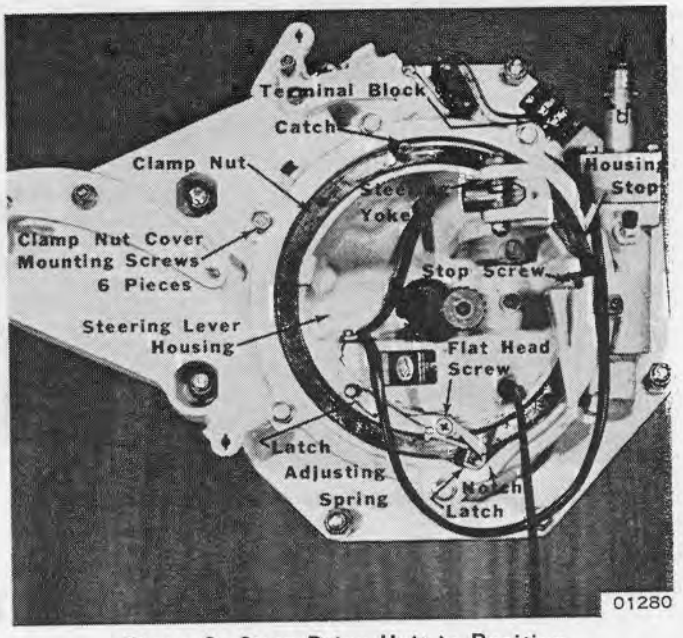

Figure 2. Stern Drive Unit in Position

LATCHES AND CATCHES

Latch and catch must be properly matched to steering lever housing to assure proper crank-up and crank-down of stern drive unit. The following chart and Figures 3-4-5-6 will assist you in selecting correct latch and catch for replacement purposes.

STEERING LEVER HSG.	LATCH	CATCH
B-32353A1	B-31961 Superseded by B-32416	B-31973
B-31867A2	B-32619	B-32616
B-32760A3	B-33638	B-33639
B-32420A2	B-35249	B-33639

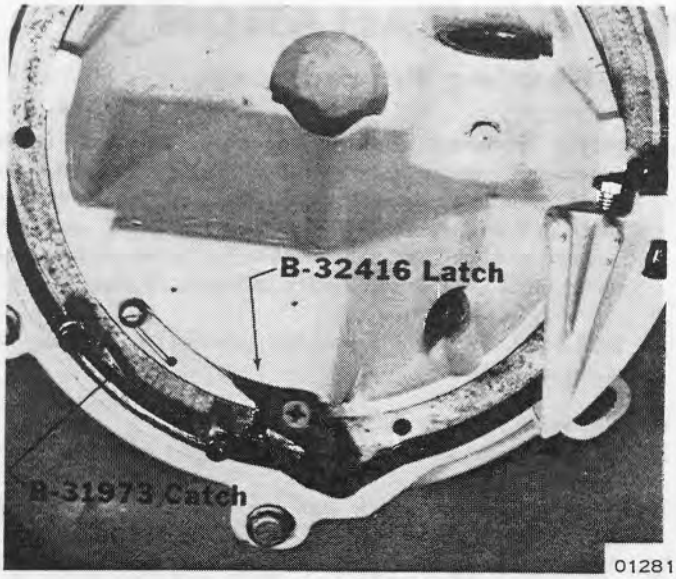

Figure 3. Steering Lever Housing B-32353A1

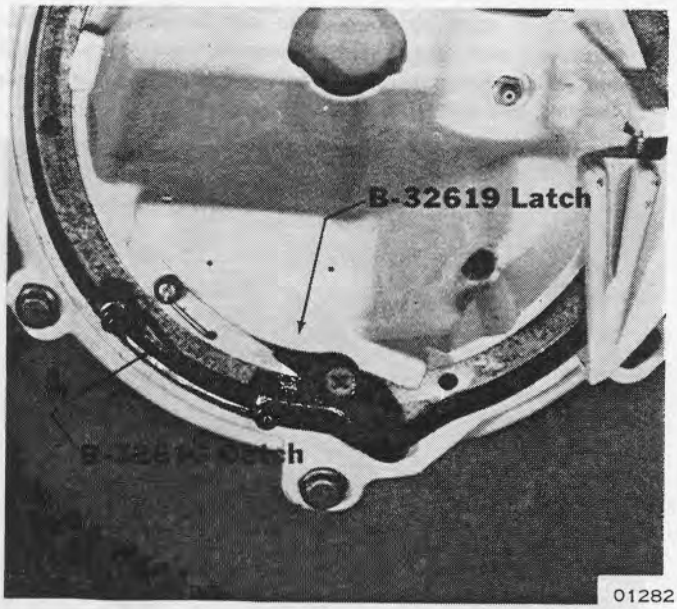

Figure 4. Steering Lever Housing B-31867A2

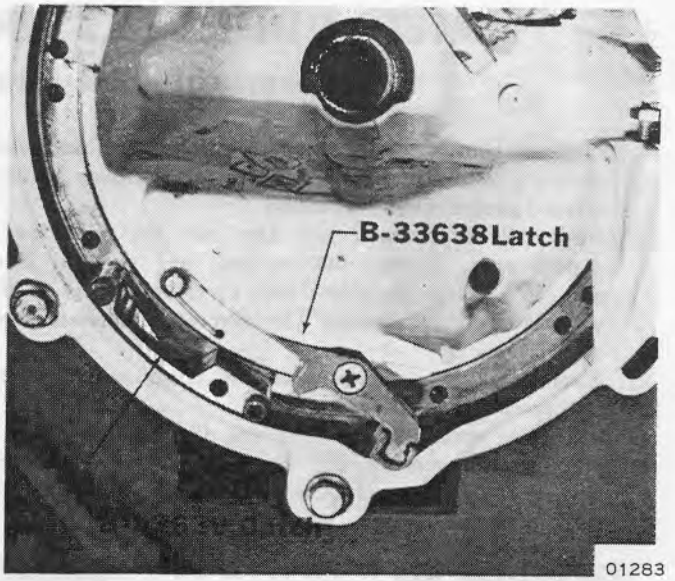

Figure 5. Steering Lever Housing B-32760A3

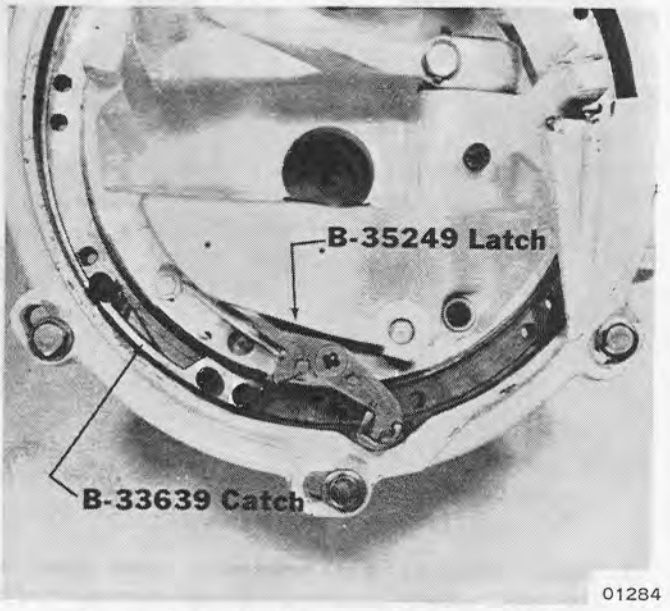

Figure 6. Steering Lever Housing B-32420A2

MERCRUISER 200-225 STERN DRIVE INSTALLATION

(For Removal - Reverse the Following Procedure)

1. Lubricate bore of outer transom plate, "O" rings and splined shaft of drive unit with New Multipurpose Quicksilver Lubricant (C-92-49588). (Figure 7)
2. Insert drive unit shift cable and tilt-up switch cable thru opening in transom plates and clamp nut.

   NOTE: When installing drive unit, place clamp nut over engine coupling with "FORWARD" tapered end toward flywheel.

3. Push unit into opening, aligning shaft spline with spline in engine coupling and locating pin with recess in drive. (Figure 8)
4. Hold drive in place and thread clamp nut onto steering drum.

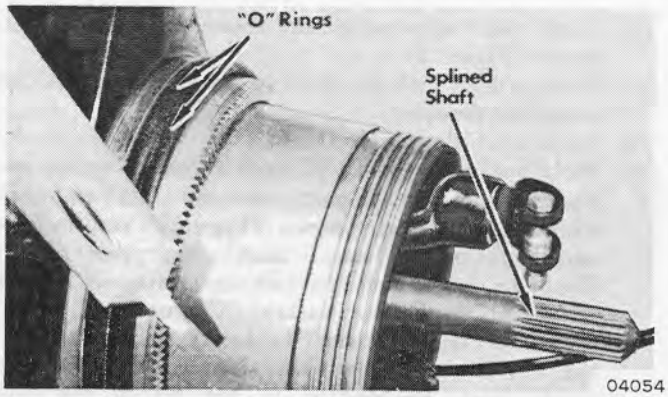

Figure 7. Lubricating Drive Unit

Figure 8. Installing Stern Drive Unit

NOTE: If, after engagement of threads, tightening is difficult, back off by turning in opposite direction. Do not force, as cross-threading may occur.

5. Use Tightening Bar (C-91-49670) to tighten clamp nut, aligning clamp nut flute with one of the 6 screw holes so that locking screw and washer may be installed. (Figure 9)

NOTE: Use locking screw (C-10-35192) and eccentric washer (C-12-54208) to retain clamp nut, if locking screw and washer will not hold clamp nut.

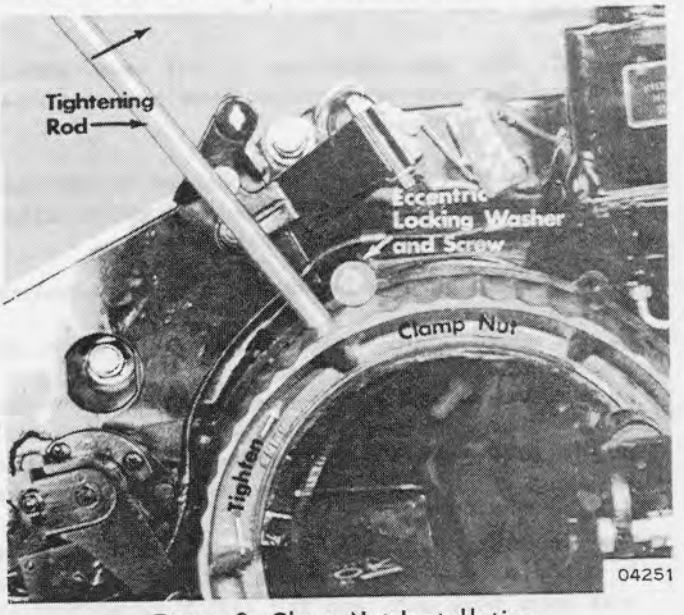

Figure 9. Clamp Nut Installation

TRANSOM PLATE INSTALLATION

1. Place outer and inner transom plates in position over drilled holes. (Figure 1) Insert lock-in switch lead thru opening in inner transom plate.
2. Insert 2 transom bolts with rubber seals under heads thru holes drilled previously. Install washers and nuts on bolts and tighten.
3. Drill the other six 9/16" (14.288mm) holes, using transom plates as a guide, and insert mounting bolts with rubber seals under heads.

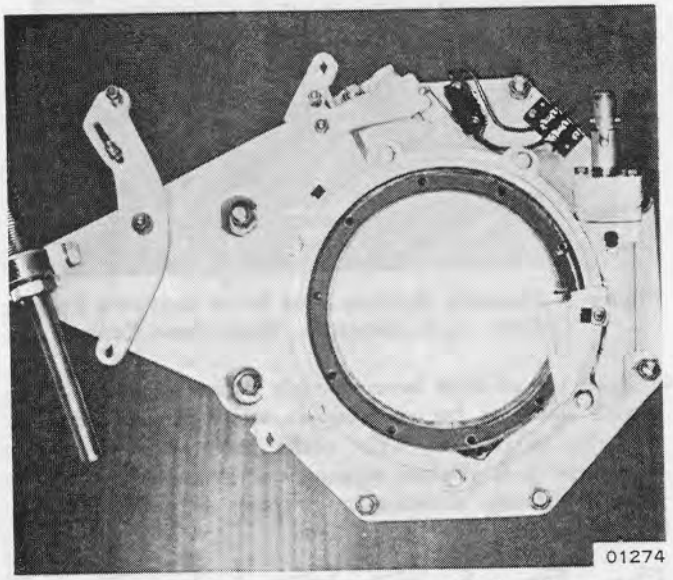

Figure 1. Inner Transom Plate Installed in Transom

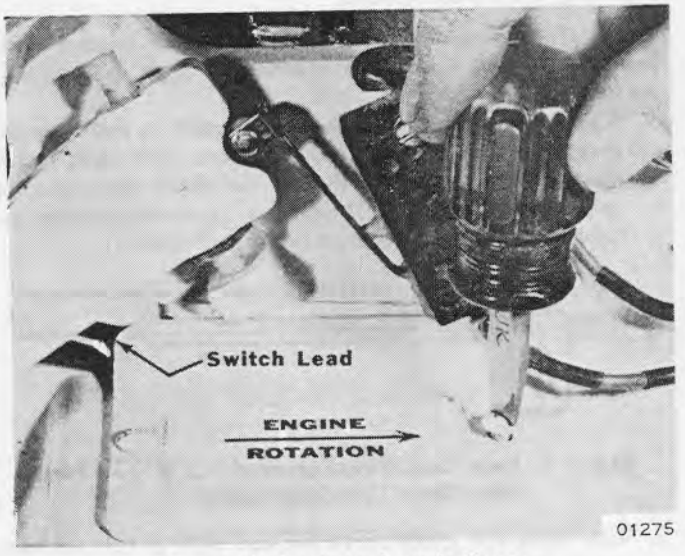

Figure 2. Lock-In Switch Cover

4. Install washers and nuts on bolts and torque all 8 nuts evenly to 30 ft. lbs. (4.148mkg). (Figure 1)
5. Place lock-in switch cover in position and fasten with 2 screws . Position switch lead as shown in Figure 2.

NOTE: If stern drive unit is not locked in operating position, and single lever remote control is not in neutral position, circuit from starter switch to starter is open and starter will not operate.

SHIFT CABLE INSTALLATION and ADJUSTMENT

IMPORTANT: Early MerCruiser II model does not have reverse lock valves. Disregard "Reverse Lock Valve Adjustment" procedure, following, for early MerCruiser II model.

NOTE: This stern drive unit is left hand rotation (counterclockwise when viewed from rear) and must use a left hand propeller.

The propeller shaft rotation can be changed to right hand by following instructions outlined under III or IV, following, and installing a right hand propeller.

- **Do not install propeller before attaching and adjusting shift cable.**
- **Do not attach throttle cable to carburetor before attaching and adjusting shift cable.**
- **Engine must be running and power shift operating when cable adjustment procedure calls for remote control handle to be moved to full forward or full reverse positions. After handle has been moved, engine may be stopped.**
- **When installing shift cables, correct adjustments must be made so that remote control station synchronizes with stern drive unit, and full clutch engagement is attained when remote control handle is in forward or reverse position.**
- **Failure to comply with the above instructions will result in damage to the stern drive shift mechanism.**

SHIFT CABLE DIMENSIONS

To obtain maximum adjustability on remote control shift cable, drive unit shift cable dimensions must be checked as follows:

1. With cable end guide removed and unit in full reverse gear, inner core wire of stern drive unit shift cable must extend exactly 1-3/8" (34.9mm) from end of cable guide insert (full forward gear engagement on right hand propeller rotation units). (Figure 1)

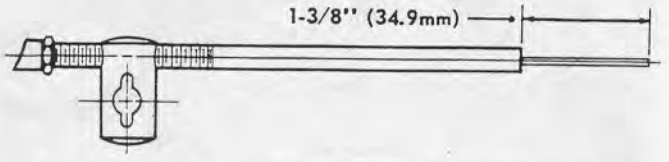

Figure 1. Inner Core Wire Extended 1-3/8" (34.9mm) Stern Drive Unit Shift Cable

2. With cable end guide installed and unit in full reverse gear (full forward gear engagement on right hand propeller rotation units), the distance from center line of brass barrel to center line of cable end guide mounting hole must be exactly 6¼" (15.87cm). (Figure 2) Readjust brass barrel to achieve this dimension.

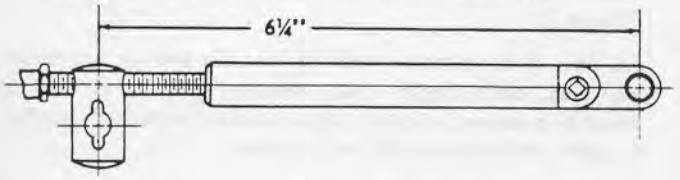

Figure 2. Center Line to Center Line Dimension 6¼" Stern Drive Unit Shift Cable

The following instructions individually outline the installation and adjustment of shift cables on the 4 following type installations:

I. Left hand propeller rotation drive unit with remote control mounted on right (starboard) side of boat.
II. Left hand propeller rotation drive unit with remote control mounted on left (port) side of boat.
III. Right hand propeller rotation drive unit with remote control mounted on right (starboard) side of boat.
IV. Right hand propeller rotation drive unit with remote control mounted on left (port) side of boat.

Select and follow instructions which apply to installation Type I, II, III or IV.

I. LEFT HAND PROPELLER ROTATION DRIVE UNIT

Remote Control Mounted on Right (Starboard Side of Boat)

REVERSE ADJUSTMENT

1. Tighten nut on pivot stud of switch lever so that lever cannot be moved. (Figure 3)
2. Fasten stern drive shift cable end guide to mounting stud on switch lever with washer and elastic stop nut. Do not tighten nut too tight, as end guide must be free to pivot on stud. (Figure 3)
3. Mount brass barrel loosely in curved slot of shift lever with cap screw, spacer, 2 washers and nut. Be sure that thick washers sandwhich shift lever. Do not tighten nut. (Figure 3)

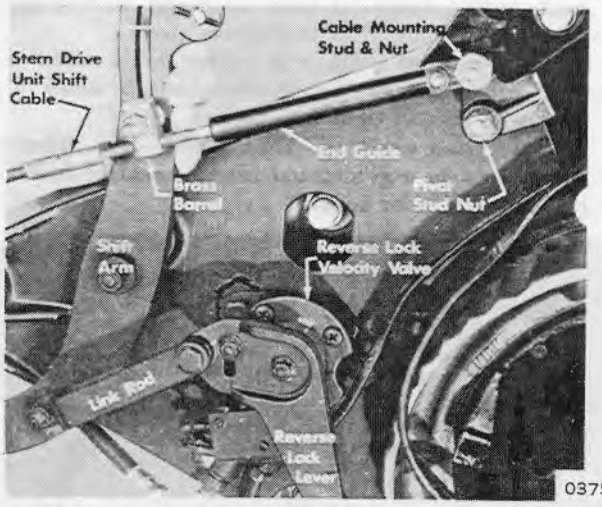

Figure 3. Manually Shifting Stern Drive Unit into Reverse Gear - L.H. Rotation - Right Hand Control

4. Push top of shift lever to right (when viewed from inside boat) as far as possible while turning propeller shaft. (Figure 3) This shifts stern drive unit into reverse gear. Proper engagement of clutch, as shown in following illustration (Figure 4), will be felt.

Figure 4. Gear Clutch Engagement

NOTE: Be sure to push lever to right as far as possible to insure full engagement of clutch teeth. Operating unit with partial engagement of teeth will cause clutch teeth corners to round off and require replacement of sliding clutch and reverse gear.

5. Move remote control handle to full reverse.
6. Anchor remote control shift cable end guide to transom plate anchor point with cap screw, 2 washers and nut. Push outer conduit toward cable guide as far as possible, to eliminate slack in cable, and adjust brass barrel to align with mounting hole in shift lever. (Figure 5)

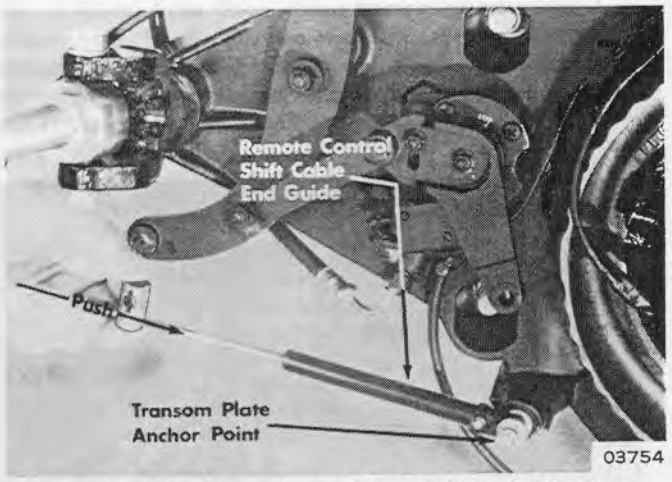

Figure 5. Adjusting Remote Control Shift Cable Brass Barrel - L.H. Rotation - Right Hand Control

7. Fasten brass barrel to shift lever with cap screw, spacer, washers and nut. Tighten nut securely. (Figure 6)
8. Remote control and stern drive now are synchronized in "Reverse" gear.

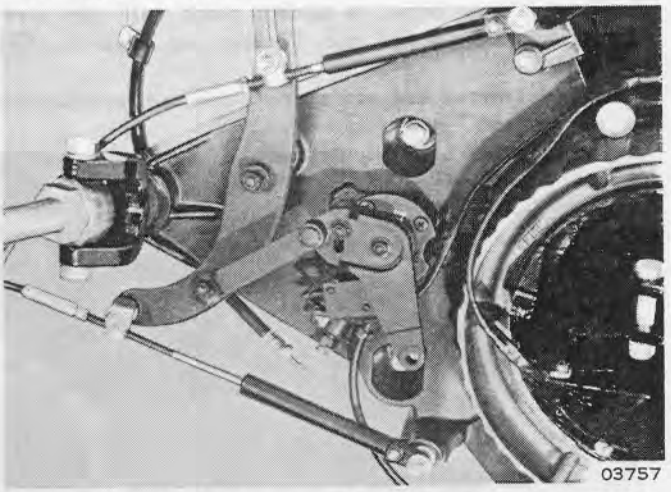

Figure 6. Shift Cables Installed - Reverse Gear - Left Hand Rotation - Right Hand Control

FORWARD ADJUSTMENT

1. Disconnect remote control shift cable end guide from transom plate anchor point.
2. Move remote control handle to full forward.
3. Pull top of shift lever to left (when viewed from inside boat) as far as possible while turning propeller shaft clockwise (when viewed from behind boat) until it cannot be turned any further.

This shifts stern drive unit into forward gear. (Figure 7) Proper engagement of clutch, as shown in illustration (Figure 4), will be felt.

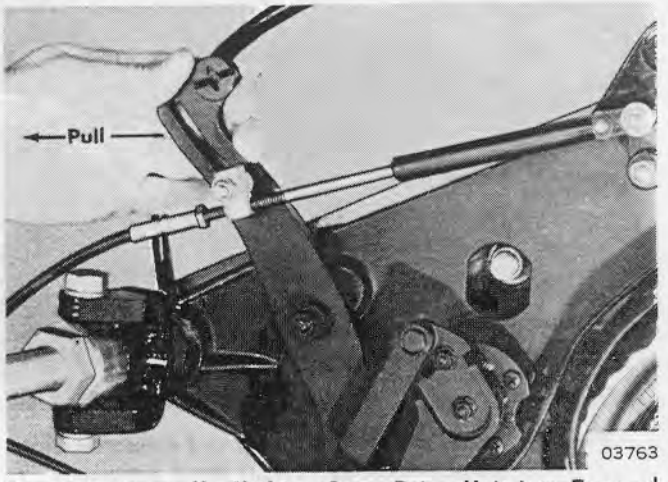

Figure 7. Manually Shifting Stern Drive Unit into Forward Gear - L.H. Rotation - R.H. Control

NOTE: Be sure to pull lever to left as far as possible to insure full engagement of clutch teeth. Operating unit with parital engagement of teeth will cause clutch teeth corners to round off and require replacement of sliding clutch and forward gear.

4. Raise brass barrel of stern drive shift cable up slot in shift lever until remote control shift cable can be reinstalled in transom plate anchor point. (Figure 8)

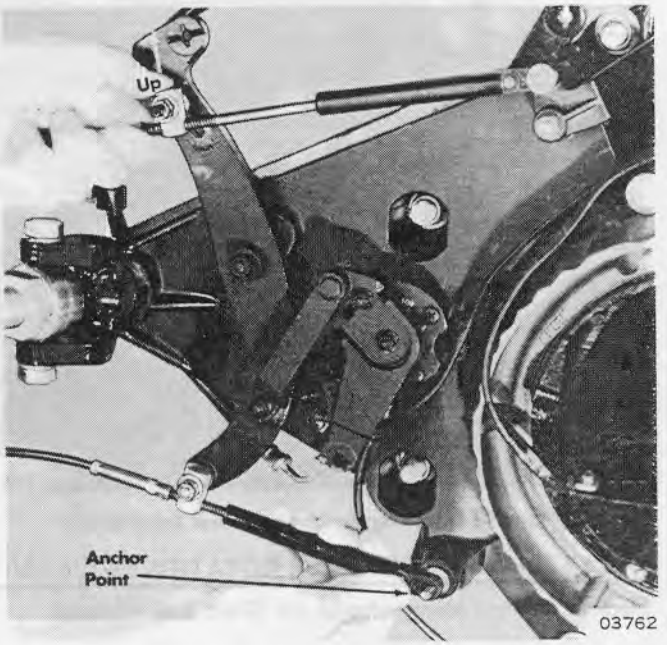

Figure 8. Positioning Stern Drive Unit Shift Cable Brass Barrel in Shift Lever Slot and Installing Cable Guide End to Transom Plate Anchor Point - L.H. Rotation - Right Hand Control

5. Continue to slide brass barrel up slot until slack is removed from remote control shift cable and tighten cap screw and nut which fastens brass barrel to shift lever securely.
6. Loosen nut on pivot stud of switch lever one full turn. Lever must pivot freely when shifting with engine running. (Figure 9)

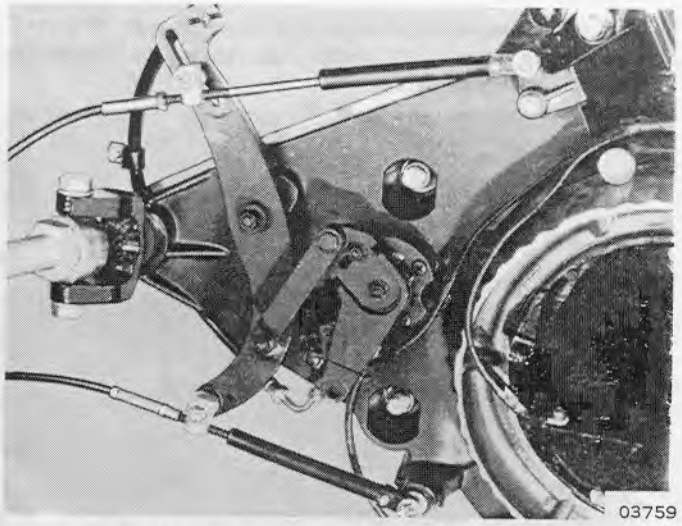

Figure 9. Shift Cables Installed and Adjusted - Left Hand Rotation - Right Hand Control

7. Reverse lock valve adjustment
   a. Shift unit into full reverse. While shifting, rotate propeller shaft counterclockwise until shaft stops, to ensure full clutch engagement.
   b. Loosen 2 nuts on reverse lock lever and move upper nut in direction required to line up raised triangular mark on reverse lock valve cover. (Figures 10 and 28) Tighten 2 nuts on reverse lock lever.

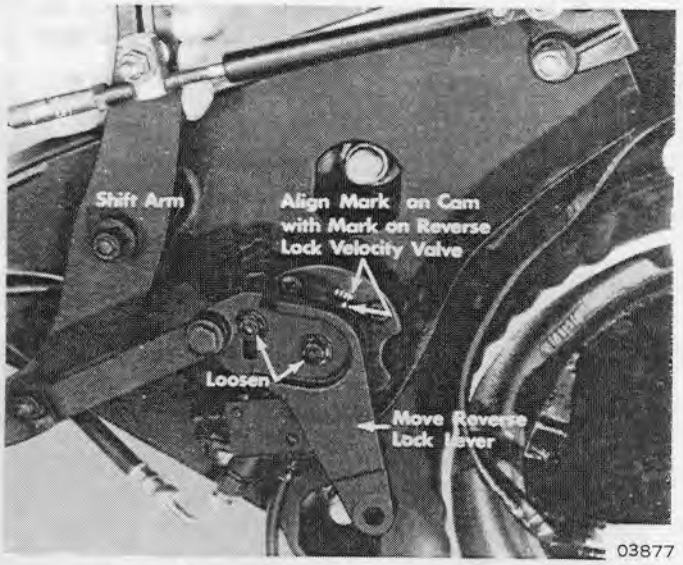

Figure 10. Reverse Lock Valve Adjustment

II. LEFT HAND PROPELLER ROTATION DRIVE UNIT

Remote Control Mounted on Left (Port Side of Boat)

REVERSE ADJUSTMENT

1. Tighten nut on pivot stud of switch lever so that lever cannot be moved. (Figure 3)
2. Fasten stern drive shift cable end guide to mounting stud on switch lever with washer and elastic stop nut. Do not tighten nut too tight, as end guide must be free to pivot on stud.(Figure 4)
3. Mount brass barrel loosely in curved slot of shift lever with cap screw, spacer, 2 washers and nut. Be sure that thick washers sandwich shift lever. Do not tighten nut. (Figure 3)
4. Push top of shift lever to right (when viewed from inside boat) as far as possible while turning propeller shaft. (Figure 3) This shifts stern drive unit into reverse gear. Proper engagement of clutch, as shown in following illustration (Figure 4), will be felt.

   NOTE: Be sure to push lever to right as far as possible to insure full engagement of clutch teeth. Operating unit with partial engagement of teeth will cause clutch teeth corners to round off and require replacement of sliding clutch and reverse gear.

5. Move remote control handle to full reverse position.
6. Anchor remote control shift cable end guide to shift lever with screw, washers and nut. Push outer conduit toward cable guide as far as possible, to eliminate slack in cable, and adjust brass barrel to align with mounting hole in transom plate anchor point. (Figure 11)

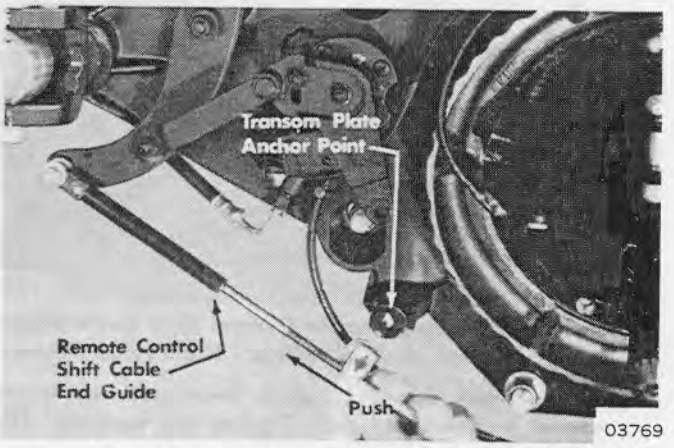

Figure 11. Adjusting Remote Control Shift Cable Brass Barrel - L.H. Rotation - Left Hand Control

7. Fasten brass barrel to anchor point with cap screw, spacer, washers and nut. Tighten nut securely. (Figure 12)
8. Remote control and stern drive now are synchronized in "Reverse" gear.

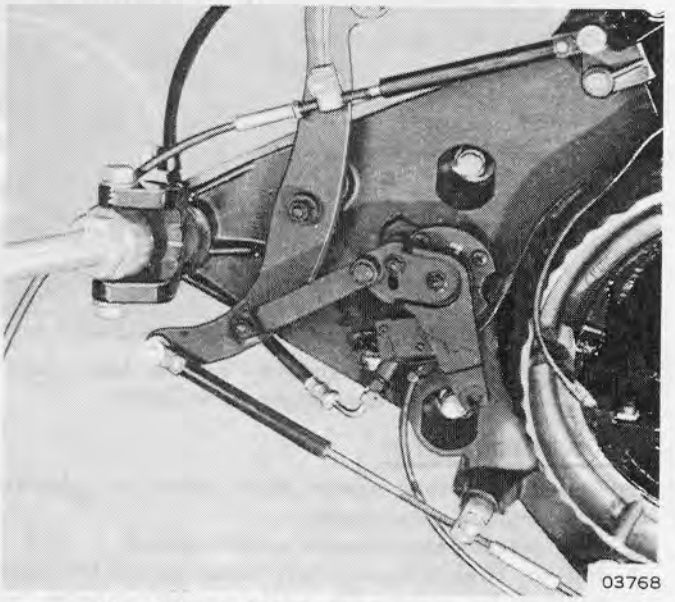

Figure 12. Shift Cables Installed - Reverse Gear - Left Hand Rotation - Left Hand Control

FORWARD ADJUSTMENT

1. Disconnect remote control shift cable end guide from shift lever.
2. Move remote control handle to full forward position.
3. Pull top of shift lever to left (when viewed from inside boat) as far as possible while having propeller shaft turned clockwise (when viewed from behind boat) until it cannot be turned any further. This shifts stern drive unit into forward gear. (Figure 13) Proper engagement of clutch, as shown in illustration (Figure 4), will be felt.

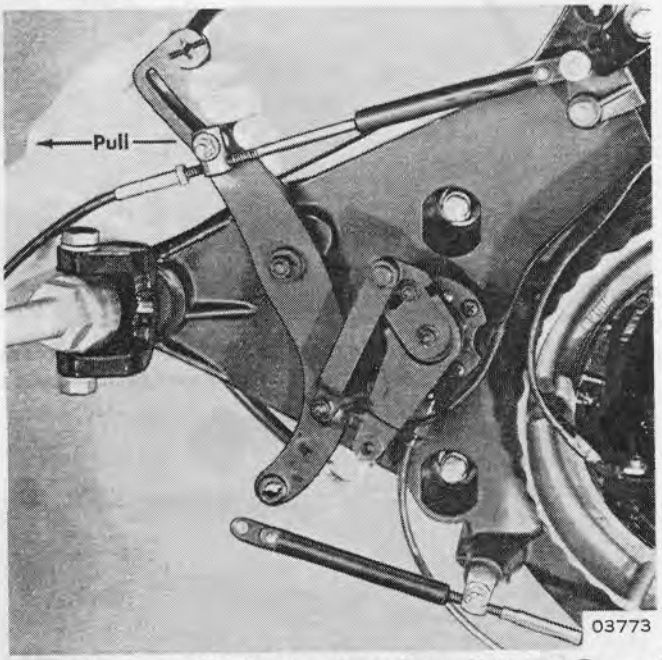

Figure 13. Manually Shifting Stern Drive Unit into Forward Gear - L.H. Rotation - Left Hand Control

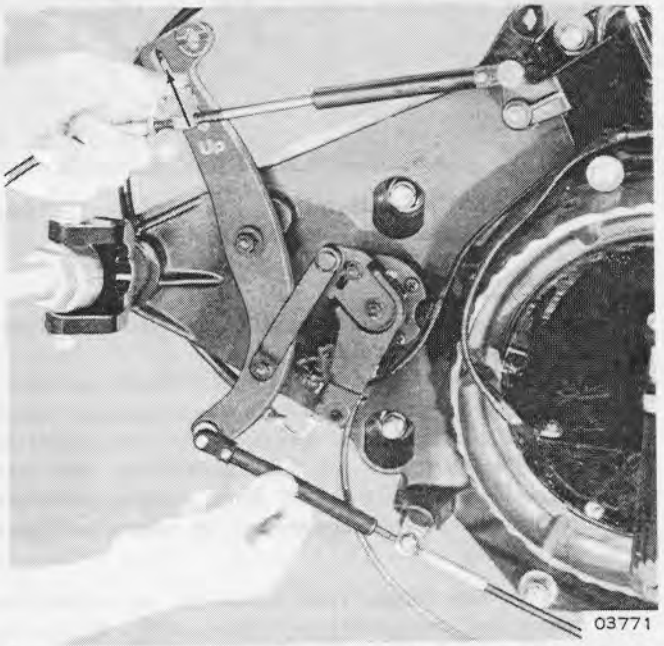

Figure 14. Positioning Stern Drive Unit Shift Cable Brass Barrel in Shift Lever Slot and Installing Cable Guide End to Shift Lever - Left Hand Rotation - Left Hand Control

NOTE: Be sure to pull lever to left as far as possible to insure full engagement of clutch teeth. Operating unit with partial engagement of teeth will cause clutch teeth corners to round off and require replacement of sliding clutch and forward gear.

4. Raise brass barrel of stern drive shift cable up slot in shift lever until remote control shift cable can be reinstalled in shift lever. (Figure 14)
5. Continue to slide brass barrel up slot until slack is removed from remote control shift cable and tighten cap screw and nut which fastens brass barrel to shift lever securely.
6. Loosen nut on pivot stud of switch lever one full turn. Lever must pivot freely when shifting with engine running. (Figure 10)
7. Reverse lock valve adjustment
   a. Shift unit into full reverse. While shifting, rotate propeller shaft clockwise until shaft stops, to ensure full clutch engagement.
   b. Loosen 2 nuts on reverse lock lever and move upper nut in direction required to line up raised triangular mark on cam with raised triangular mark on reverse lock valve cover. (Figure 10) Tighten 2 nuts on reverse lock lever.

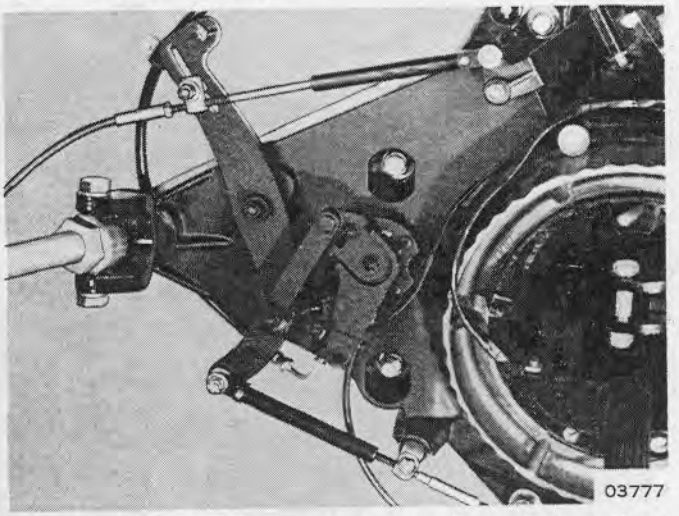

Figure 15. Shift Cables Installed and Adjusted - Left Hand Rotation - Left Hand Control

III. RIGHT HAND PROPELLER ROTATION DRIVE UNIT

Remote Control Mounted on Right (Starboard Side of Boat)

Convert left hand rotation drive units to right hand rotation by removing link rod end from upper reverse lock lever arm and reinstalling into lower arm. (Figure 21)

FORWARD ADJUSTMENT

1. Tighten nut on pivot stud of switch lever so that lever cannot be moved. (Figure 17)
2. Fasten stern drive shift cable end guide to mounting stud on switch lever with washer and elastic stop nut. Do not tighten nut too tight, as end guide must be free to pivot on stud.
3. Mount brass barrel loosely in curved slot of shift lever with cap screw, spacer, 2 washers and nut. Be sure that thick washers sandwich shift lever. Do not tighten nut. (Figure 17)

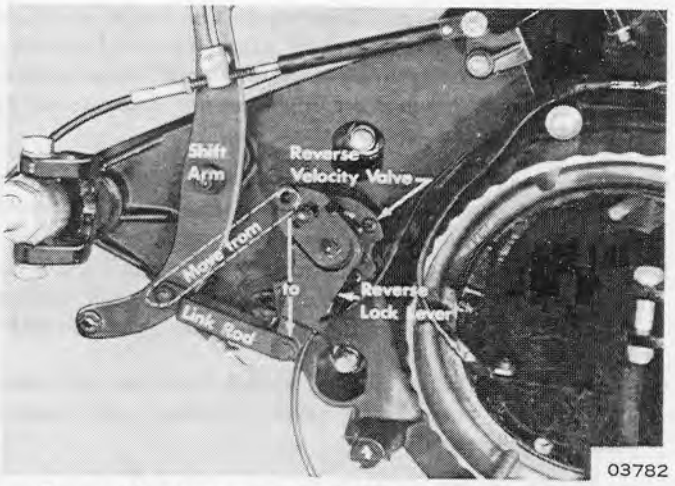

Figure 16. Converting Left Hand Rotation to Right

4. Push top of shift lever to right (when viewed from inside boat) as far as possible while having propeller shaft turned counterclockwise (when viewing from behind boat) until it cannot be turned any further. This shifts stern drive unit into forward gear. (Figure 17) Proper engagement of clutch, as shown in illustration (Figure 4), will be felt.

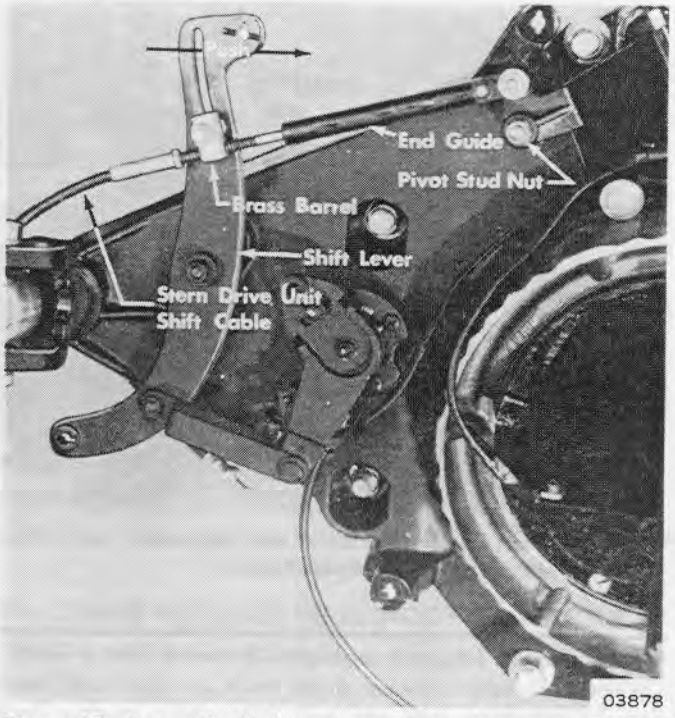

Figure 17. Manually Shifting Stern Drive Unit into Forward Gear - R.H. Rotation - R.H. Control

NOTE: Be sure to push lever to right as far as possible to insure full engagement of clutch teeth. Operating unit with partial engagement of teeth will cause clutch teeth corners to round off and require replacement of sliding clutch and forward gear.

5. Move remote control handle to full forward position.
6. Anchor remote control shift cable end guide to transom plate anchor point with screw, washers and nut. Pull outer conduit away from cable guide as far as possible, to eliminate slack in cable, and adjust brass barrel to align with mounting hole in shift lever. (Figure 18)
7. Fasten brass barrel to shift lever with cap screw, spacer, washers and nut. Tighten nut securely. (Figure 19)
8. Remote control and stern drive now are synchronized in "Forward" gear. (Figure 19)

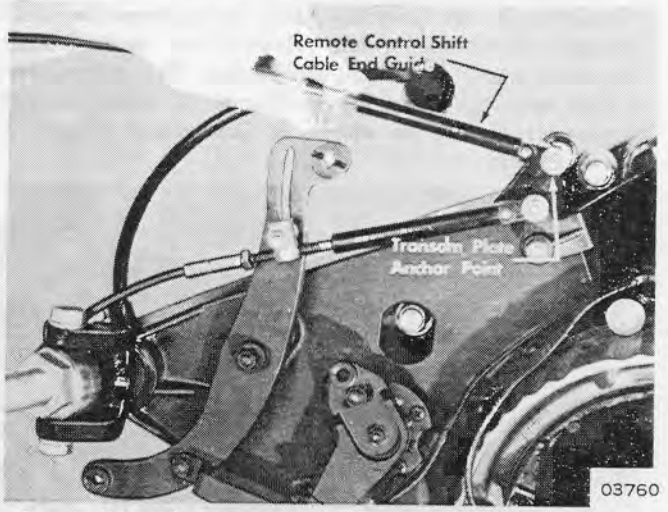

Figure 18. Adjusting Remote Control Shift Cable Brass Barrel - R.H. Rotation - Right Hand Control

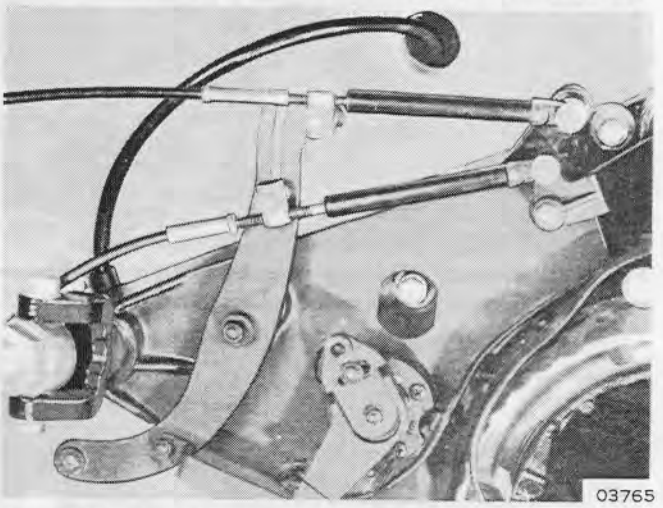

Figure 19. Shift Cables Installed - Forward Gear - Right Hand Rotation - Right Hand Control

REVERSE ADJUSTMENT

1. Disconnect remote control shift cable end guide from transom plate anchor point.
2. Move remote control handle to full reverse position.
3. Rotate propeller shaft clockwise and manually move shift lever to left (when viewing lever from inside of boat) as far as it will go. This shifts drive unit into "Reverse" gear. (Figure 20) When rotating propeller shaft, reverse clutch engagement, as shown in Figure 4, will be felt.

   NOTE: Be sure to pull lever to left as far as possible to insure full engagement of clutch teeth. Operating unit with partial engagement of teeth will cause clutch teeth corners to round off and require replacement of sliding clutch and reverse gear.

4. Raise brass barrel of stern drive shift cable up slot in shift lever until remote control shift cable can be reinstalled in transom plate anchor point. (Figure 21)

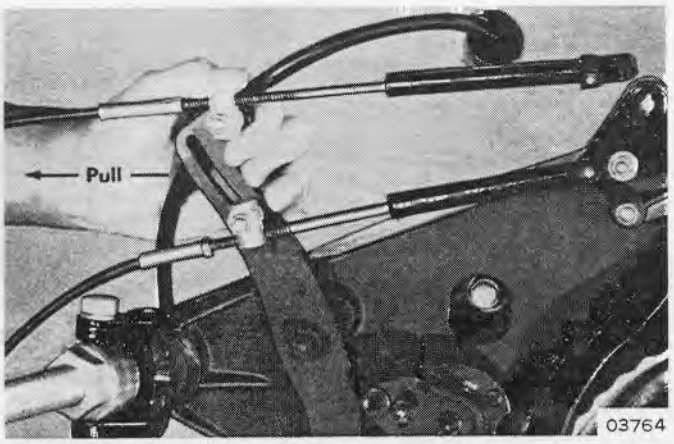

Figure 20. Manually Shifting Stern Drive Unit into Reverse Gear - R.H. Rotation - R.H. Control

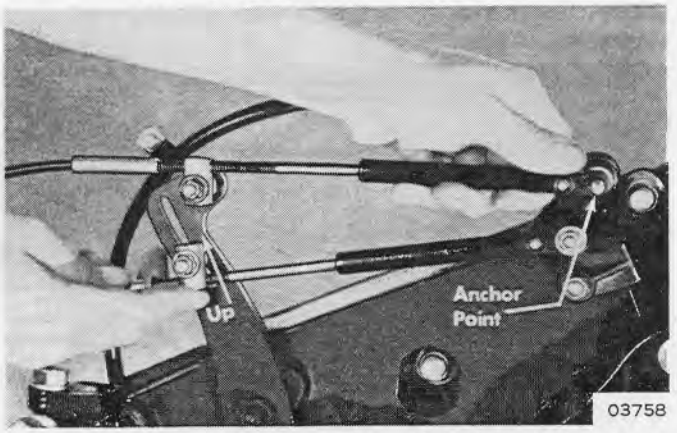

Figure 21. Positioning Stern Drive Unit Shift Cable Brass Barrel in Shift Lever Slot and Installing Cable Guide End to Transom Plate Anchor Point - Right Hand Rotation - Right Hand Control

5. Continue to slide brass barrel up slot until slack is removed from remote control shift cable and securely tighten cap screw and nut which fastens brass barrel to shift lever.
6. Loosen nut on pivot stud of switch lever one full turn. Lever must pivot freely when shifting with engine running. (Figure 17)

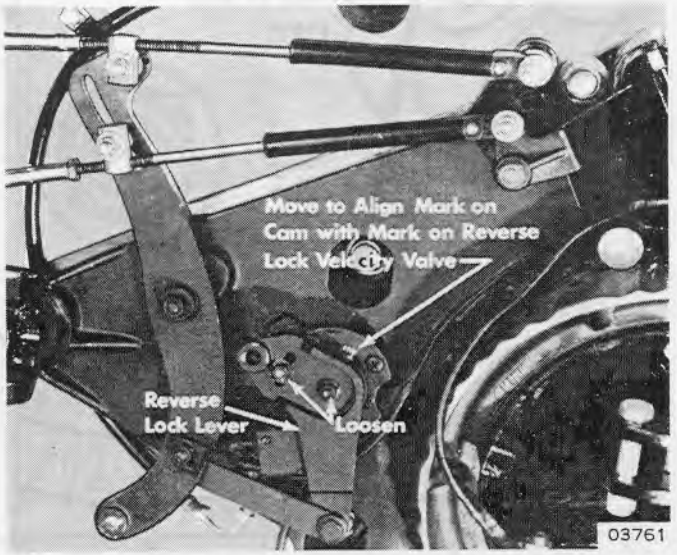

Figure 22. Reverse Lock Valve Adjustment

7. Reverse lock valve adjustment
   a. Shift unit into full reverse. While shifting, rotate propeller shaft clockwise until shaft stops, to ensure full clutch engagement.
   b. Loosen 2 nuts on reverse lock lever and move upper nut in direction required to line up raised triangular mark on cam with raised triangular mark on reverse lock valve cover. (Figures 22 and 28) Tighten 2 nuts on shift lever.

IV. RIGHT HAND PROPELLER ROTATION DRIVE UNIT

Remote Control Mounted on Left (Port) Side of Boat

Convert left hand rotation drive units to right hand rotation by removing link rod end from upper reverse lock lever arm and reinstalling into lower arm. (Figure 16)

FORWARD ADJUSTMENT

1. Tighten nut on pivot stud of switch lever so that lever cannot be moved. (Figure 17)
2. Fasten stern drive shift cable end guide to mounting stud on switch lever with washer and elastic stop nut. Do not tighten nut too tight, as end guide must be free to pivot on stud. (Figure 17)
3. Mount brass barrel loosely in curved slot of shift lever with cap screw, spacer, 2 washers and nut. Be sure that thick washers sandwich shift lever. Do not tighten nut. (Figure 17)

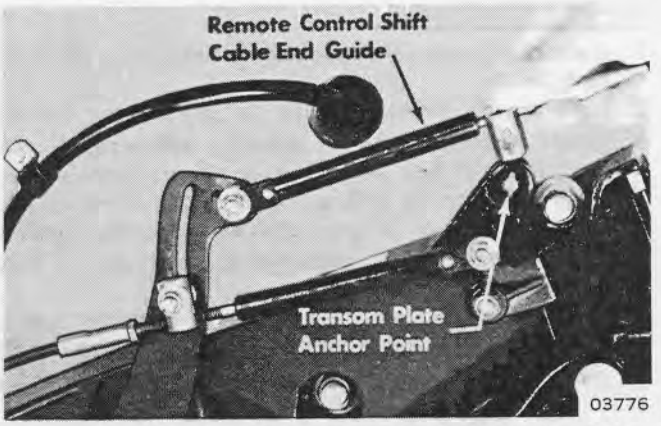

Figure 23. Adjusting Remote Control Shift Cable Brass Barrel - R.H. Rotation - Left Hand Control

4. Push top of shift lever to right (when viewed from inside boat) as far as possible while having propeller shaft turned counterclockwise (when viewing from behind boat) until it cannot be turned any further. This shifts stern drive unit into forward gear. (Figure 17) Proper engagement of clutch, as shown in Figure 4, will be felt.

   NOTE: Be sure to push lever to right as far as possible to insure full engagement of clutch teeth. Operating unit with partial engagement of teeth will cause clutch teeth corners to round off and require replacement of sliding clutch and forward gear.

5. Move remote control handle to full forward position.
6. Anchor remote control shift cable end guide to shift lever with screw, washers and nut. Pull outer conduit away from cable guide as far as possible, to eliminate slack in cable, and adjust brass barrel to align with mounting hole in transom plate anchor point. (Figure 23)

7. Fasten brass barrel to anchor point with cap screw, spacer, washers and nut. Tighten nut securely. (Figure 24)

NOTE: Fasten control cable behind hydraulic pump with nygrip clamp.

8. Remote control and stern drive now are synchronized in "Forward" gear.

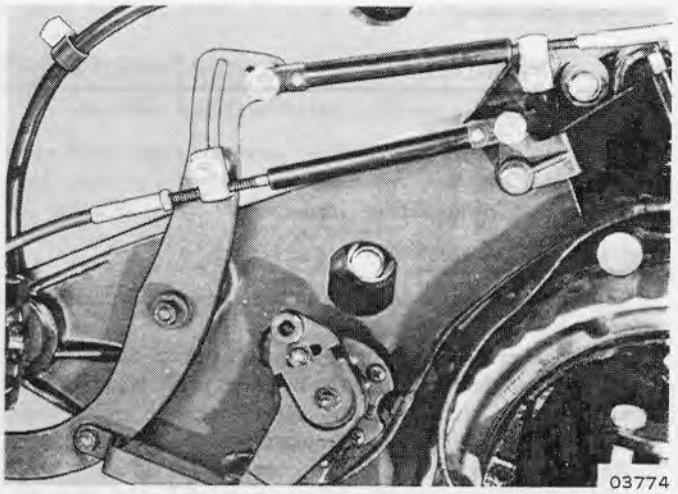

Figure 24. Shift Cables Installed - Forward Gear - Right Hand Rotation - Left Hand Control

REVERSE ADJUSTMENT

1. Disconnect remote control shift cable end guide from shift lever.
2. Move remote control handle to full reverse position.
3. Rotate propeller shaft clockwise and manually move shift lever to left (when viewing lever from inside of boat) as far as it will go. This shifts drive unit into "Reverse" gear. (Figure 25) When rotating propeller shaft, reverse clutch engagement, as shown in Figure 4, will be felt.

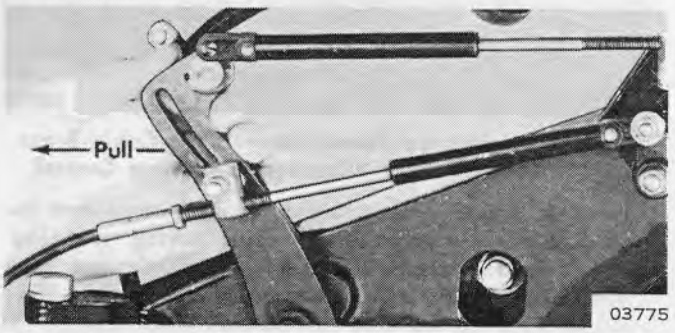

Figure 25. Manually Shifting Stern Drive Unit into Reverse Gear - R.H. Rotation - Left Hand Control

NOTE: Be sure to pull lever to left as far as possible to insure full engagement of clutch teeth. Operating unit with partial engagement of teeth will cause clutch teeth corners to round off and require replacement of sliding clutch and reverse gear.

4. Raise brass barrel of stern drive shift cable up slot in shift lever until remote control shift cable can be reinstalled in shift lever. (Figure 26)
5. Continue to slide brass barrel up slot until slack is removed from remote control shift cable and securely tighten cap screw and nut which fastens brass barrel to shift lever.

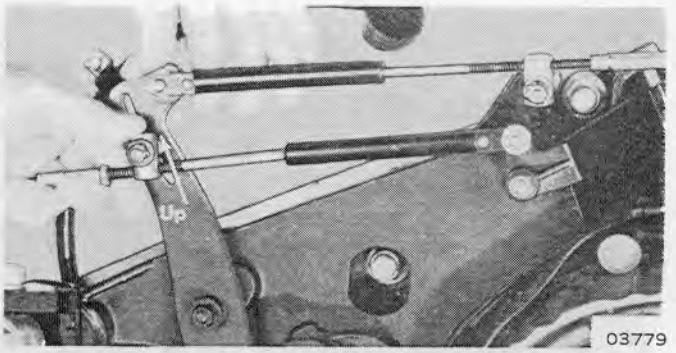

Figure 26. Positioning Stern Drive Unit Shift Cable Brass Barrel in Shift Lever Slot and Installing Shift Cable Guide End to Shift Lever - Right Hand Rotation - Left Hand Control

6. Loosen nut on pivot stud of switch lever one full turn. Lever must pivot freely when shifting with engine running. (Figure 27)

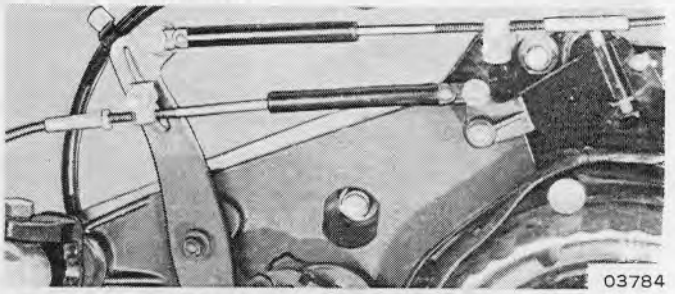

Figure 27. Shift Cables Installed and Adjusted - Right Hand Rotation - Left Hand Control

7. Reverse lock valve adjustment
   a. Shift unit into full reverse. While shifting, rotate propeller shaft counterclockwise until shaft stops, to ensure full clutch engagement.
   b. Loosen 2 nuts on reverse lock lever and move upper nut in direction required to line up raised triangular mark on cam with raised triangular mark on reverse lock valve cover. (Figures 22 and 28) Tighten 2 nuts on shift lever.

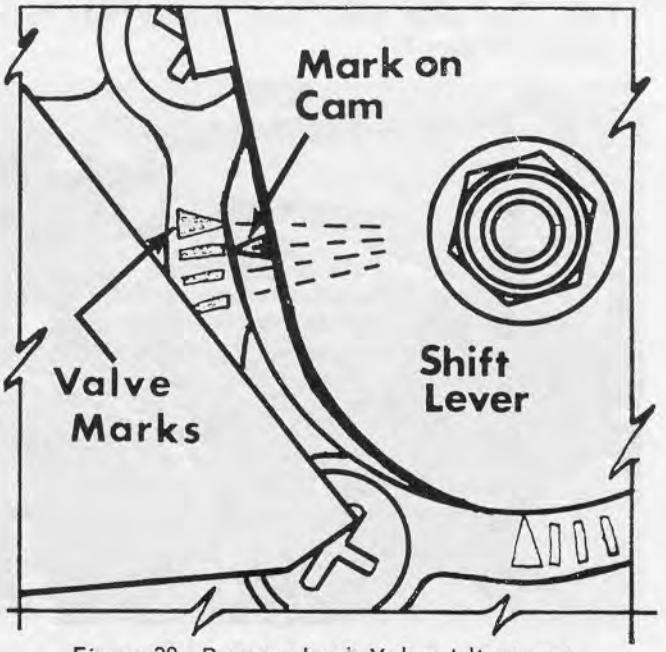

Figure 28. Reverse Lock Valve Adjustment

THROTTLE CONTROL CABLE ATTACHMENT

MERCRUISER 200 and 225

1. Fasten throttle cable to side and transom of boat with clips to form a gradual bend leading to throttle lever linkage.
2. Place remote control handle in neutral and neutral warmup lever down before attaching cable.

   NOTE: If knurled pin is in cable guide end, remove pin and spring.
3. Remove nut and one washer from screw which passes thru carburetor throttle lever.
4. Place cable end guide over spacer. Place flat washer and nut on screw and tighten nut securely. (Figures 1, 2 and 4)

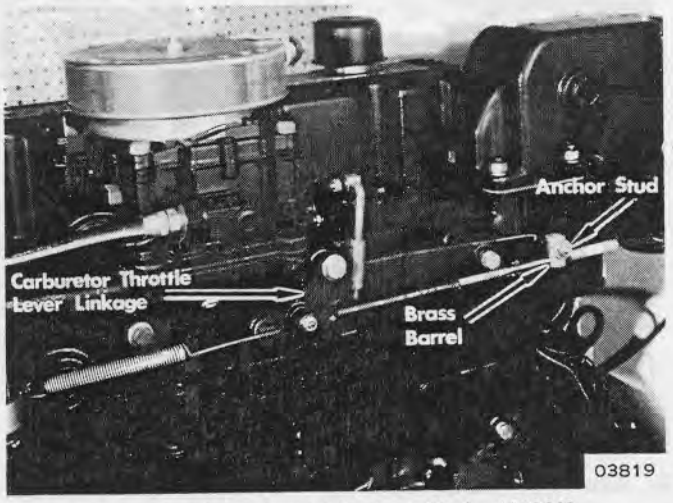

Figure 1. Throttle Cable Installed - "200"

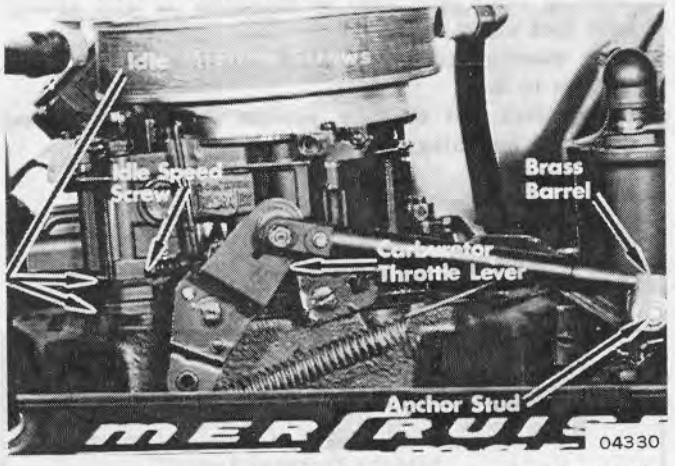

Figure 2. Throttle Cable Installed - Late Model "225"

5. Grasp throttle cable behind brass barrel and push toward throttle arm.
   Adjust brass barrel to align with anchor stud in bracket. Place flat washer, sleeve and barrel on stud.
   Place flat washer and stop nut on stud and tighten nut securely. (Figures 1, 2 and 4)
6. Check that primary throttle valves are fully open when remote control handle is all the way forward.
7. Set engine idle speed at 500-600 RPM in forward gear by adjusting idle stop screw on carburetor. Turn screw in to increase RPM; back screw out to decrease RPM.

MERCRUISER II

1. Fasten throttle cable to side and transom of boat with clips to form a gradual bend leading to throttle arm.
2. Place remote control handle in neutral and neutral warm-up lever down before attaching cable.
3. Attaching cable end guide and brass barrel:

   EARLY MODEL CARBURETORS

   a. Remove roll pin, which passes thru knurled pin in cable end guide, and remove pin and spring.
   b. Remove nut and one washer from screw which passes thru carburetor throttle lever.
   c. Place cable end guide over spacer. Place flat washer and nut on screw and tighten nut securely.
   d. Grasp throttle cable behind brass barrel and push toward throttle arm. Adjust brass barrel to align with anchor stud in bracket. Place flat washer, sleeve and barrel on stud. Place flat washer and stop nut on stud and tighten nut securely.

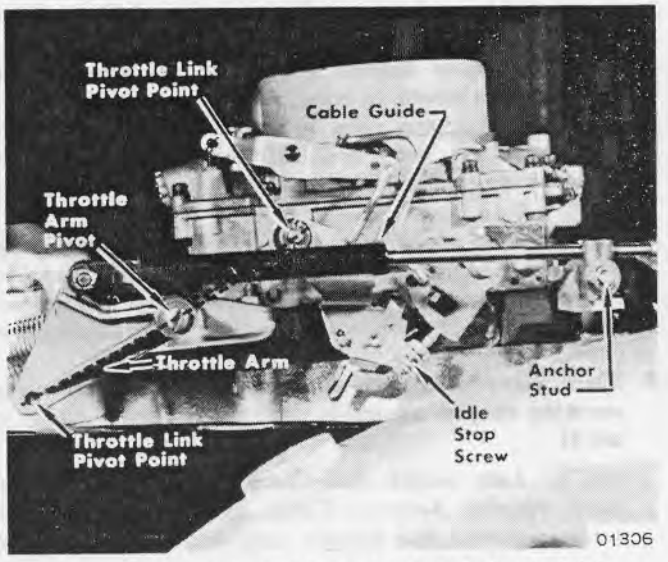

Figure 3. Throttle Cable Installed (Early Models)

LATE MODEL CARBURETORS

a. Remove roll pin, which passes thru knurled pin in cable end guide, and remove pin and spring.

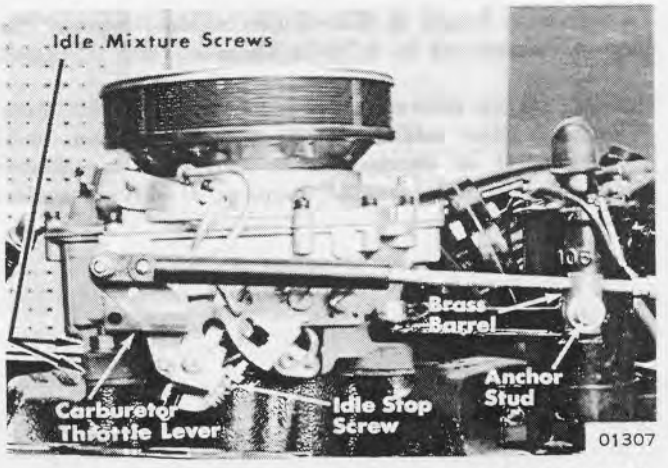

Figure 4. Throttle Cable Installed - Early Model "225" and Late Model MerCruiser II

b. Attach cable end guide to throttle arm with sleeve, screw and elastic stop nut.
c. Position throttle arm so that 2 throttle link pivot points are in line with throttle arm pivot stud. (Fig-4) While holding arm in this position, grasp throttle cable behind brass barrel and push toward throttle arm. Adjust brass barrel to align with anchor stud in bracket. Place flat washer, sleeve and barrel on stud. Place flat washer and stop nut on stud and tighten nut securely.

4. Check that primary throttle valves are fully open when remote control handle is all the way forward.

   Return control handle to neutral and check that throttle valves are fully closed.

5. Set engine idle speed at 500-600 RPM in forward gear by adjusting idle stop screw on carburetor.

   Turn screw in to increase RPM; back screw out to decrease RPM.

RIDE-GUIDE STEERING

ATTACHING STEERING CABLE to STERN DRIVE UNIT

1. Lubricate steering cable tube end with New Multipurpose Quicksilver Lubricant (C-92-49588).
2. Screw steering pivot yoke into bracket until it seats, then back off one turn to prevent binding when unit is rotated 180°. (Figure 5)
3. Insert cable end thru tube and thread large hand-type fastening nut on loosely. (Figure 5)
4. Remove coupler halves from yoke of steering arm. Do not lose sleeves in yoke.
5. Screw steering arm yoke in until it seats in steering arm, then back out 1-to-2 full turns. (Figure 5) This prevents yoke from binding when unit is rotated up 180°.
6. Turn steering wheel so that cable end is out far enough to attach coupler halves into groove at end of cable.
7. Place coupler halves in Ride-Guide cable tube groove and place cable with coupler halves into steering arm yoke.
8. Place sleeves in yoke and insert cap screw from top, securing coupler assembly with elastic stop nut. (Figure 5)

   NOTE: Late model Ride-Guide cable does not require coupler halves. Cable is secured with cap screw, spacers and elastic stop nuts. (Fig. 5 Insert)

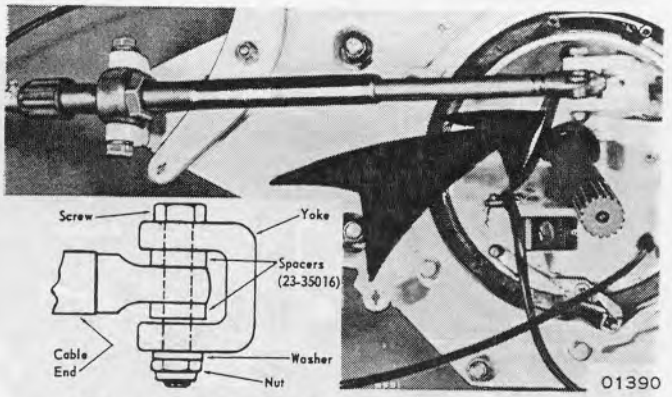

Figure 5. Ride-Guide Steering Attachment

ADJUSTING RIDE-GUIDE CABLE

1. Turn Ride-Guide steering wheel to extreme right position.
2. Steering cable tube must be threaded in fully against yoke lock nut.
3. Turn steering tube out until steering wheel starts to move to left.
4. Secure lock nut on tube against swivel and tighten hand-type fastening nut on cable.

RIDE-GUIDE CABLE MEASUREMENT

To determine length of Ride-Guide cables, measure from large aluminum nut to 9/16-18 threaded end. (Figure 6)

NOTE: When measuring boats for control cable installation, allow additional length for unusual cable routing. It is impossible to arrive at a universal formula for cable lengths because of varying applications.

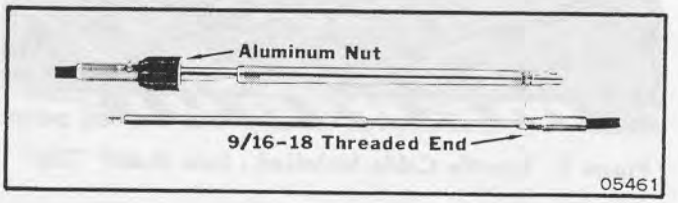

Figure 6. Ride-Guide Cable Measurement

SECTION 2 - REMOVAL, INSTALLATION and ALIGNMENT

MERCRUISER

PART D - MERCRUISER II STERN DRIVE

(ENGINE TRANSOM MOUNTED)

MERCURY MARINE

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MERCRUISER II (TRANSOM MOUNTED)

ENGINE REMOVAL

NOTE: Stern drive unit must be removed prior to engine removal, if engine cannot be moved forward sufficiently to clear drive shaft. Removal procedure is reverse of installation.

1. Disconnect battery cables from battery and remove instrument panel harness connector plug from engine harness receptacle.
2. Disconnect fuel line, throttle and shift control cables.
3. Disconnect reverse lock switch wires, trim indicator switch wires and hydraulic pump motor wire from engine.
4. Remove water inlet tube and exhaust tubes.
5. Support engine with a suitable sling thru the lifting eyes on engine and remove front and rear engine mounting bolts.
6. Remove engine.

ENGINE INSTALLATION and ALIGNMENT

NOTE: Prior to installing engine, transom plates must be installed as outlined in stern drive installation, following.

1. Place one large steel washer, one double-wound lockwasher and one neoprene washer on top of each inner transom plate engine support. (Figure 1)

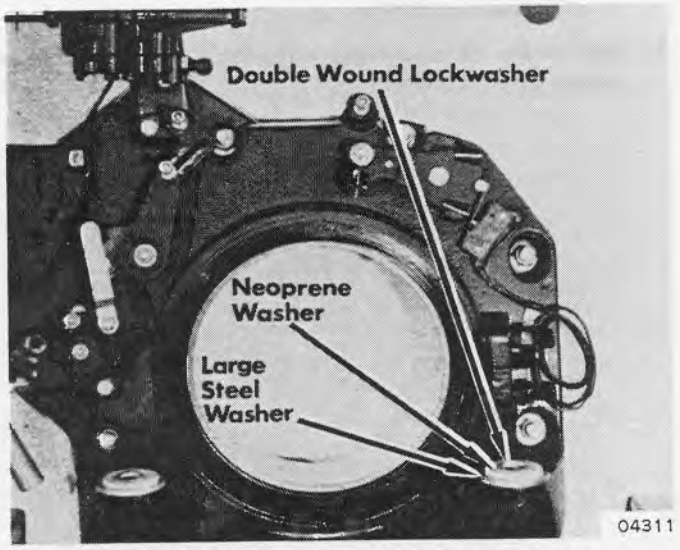

Figure 1. Washers Positioned on Transom Plate Engine Support

2. Lift engine with an overhead hoist, using a suitable sling and lifting eyes on engine.

   NOTE: Remove plastic shipping plug from engine coupling spline and lubricate splines with New Multipurpose Lubricant (C-92-49588) which is supplied with stern drive.

3. Place engine in position over transom plate and relieve hoist tension, as required, to allow rear mounts to rest on engine supports and washers.
4. Place one neoprene washer and one steel washer on top of each engine mount and insert bolts down thru washers, mounts and engine supports. Place one steel washer on each bolt and thread on elastic stop nut. Tighten nut to 100 ft. lbs. (13.8mkg.) (Figure 2)

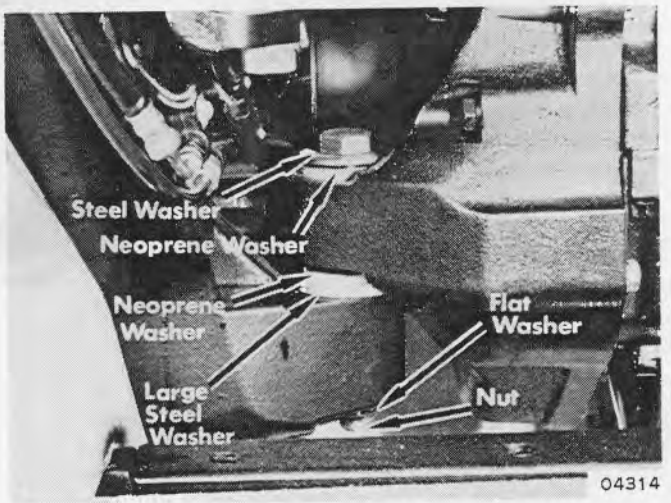

Figure 2. Rear Engine Mount Parts Location

5. Raise or lower front of engine with hoist, as required, to allow alignment rod to be positioned in recess located in inner transom plate and recess located in flywheel housing. (Figure 3)

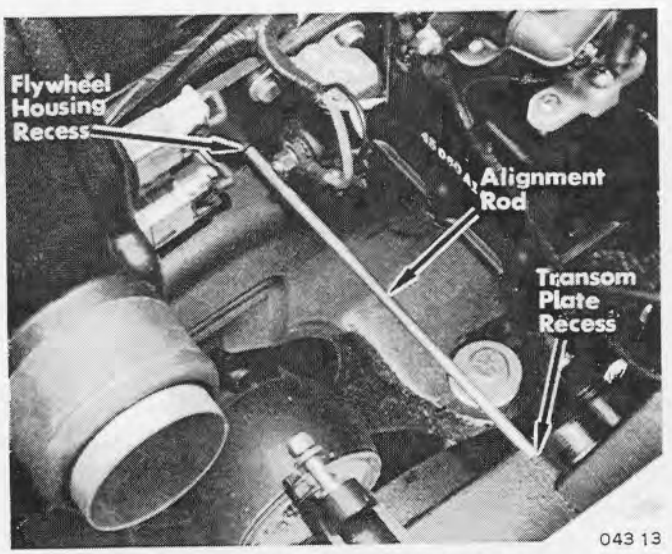

Figure 3. Alignment Rod Position

6. With alignment rod in position and front of engine supported with hoist, adjust front engine mounts so that mount bases rest on top of boat stringers. Width of front mount bases can be adjusted by loosening screw and nut "A" in Figure 4 on each mount bracket and sliding mounts in or out. Do not position mounts out away from brackets more than ¾" (19mm), as shown in Figure 4. Mount height can be adjusted by turning bolt "B" in Figure 4 clockwise to lower mount or counter-clockwise to raise mount.

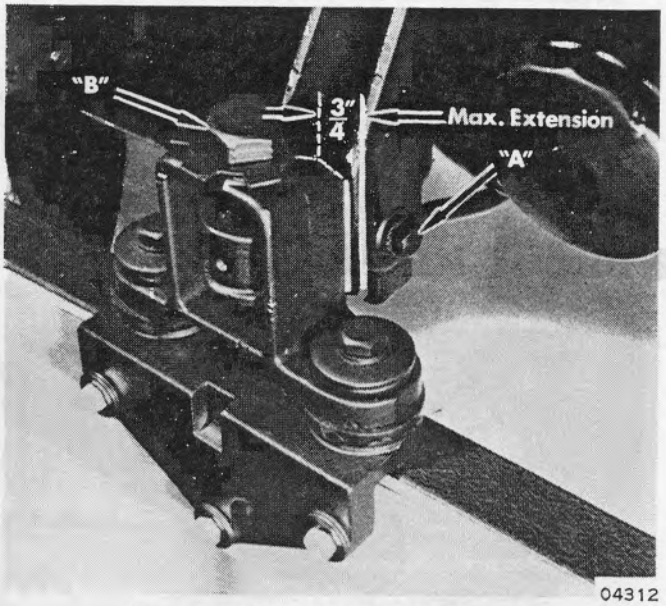

Figure 4. Front Mount Adjustments

7. Relieve hoist tension entirely. Fasten each mount base securely to stringer with three 3/8" dia. bolts, washers and locknuts. (Figure 4)
8. Check engine alignment rod fit. Rod should just fit in recesses in inner transom plate and flywheel housing. Rod should not have any fore-and-aft movement but should not be so tight that it cannot be removed by hand.
9. If alignment rod fit is not as described in preceding Step 8, proceed as follows:
   a. If rod is too loose, raise front of engine by turning adjusting bolt, "B" in Figure 4, on both mounts clockwise. Turn both adjusting bolts an equal amount by alternating from one side to the other until alignment rod fit is correct.
   b. If rod is too tight, lower front of engine by turning adjusting bolt, "B" in Figure 4, on both mounts counterclockwise. Turn both adjusting bolts equal amount by alternating from one side to the other until alignment rod fit is correct.

   NOTE: Alignment Rod (B-47457) length is 9.775" (24.8cm) (± .010").
10. Bend tabs of mount adjusting bolt tab washers down over edges of mounts.

MERCRUISER 200-225 STERN DRIVE INSTALLATION

(For Removal, Reverse the Following Procedure.)

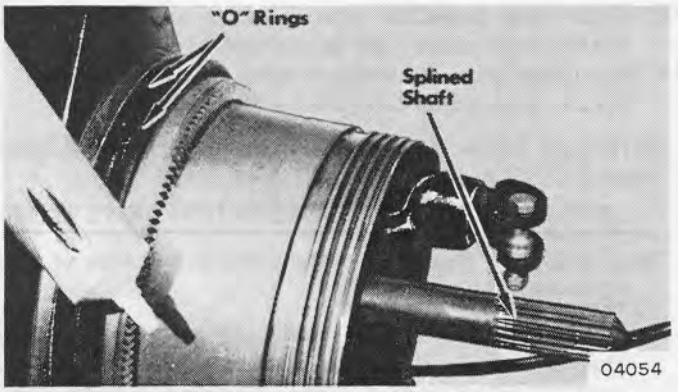

Figure 5. Lubricating Drive Unit

1. Lubricate bore of outer transom plate, "O" rings and splined shaft of drive unit with New Quicksilver Lubricant (C-92-49588). (Figure 5)
2. Insert drive unit shift cable and tilt-up switch cable thru opening in transom plates and clamp nut.

   NOTE: When installing drive unit, place clamp nut over engine coupling with "FORWARD" tapered end toward flywheel.

3. Push unit into opening, aligning shaft spline with spline in engine coupling and locating pin with recess in drive. (Figure 6)
4. Hold drive in place and thread clamp nut onto steering drum.

   NOTE: If, after engagement of threads, tightening is difficult, back off by turning in opposite direction. Do not force, as cross-threading may occur.

5. Use Tightening Bar (C-91-49670) to tighten clamp nut, aligning clamp nut flutes with backing screws. (Figure 7) Snug locking screw and tighten lock nuts. (Figure 8)

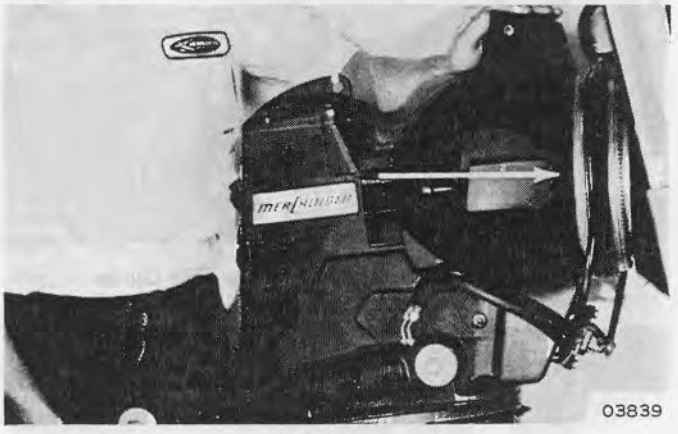

Figure 6. Installing Stern Drive Unit

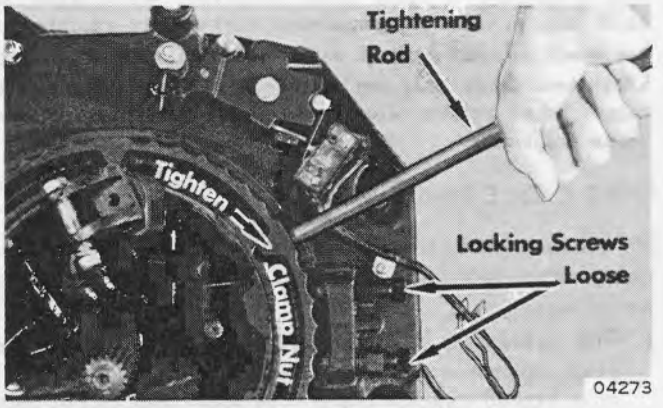

Figure 7. Clamp Nut Installation

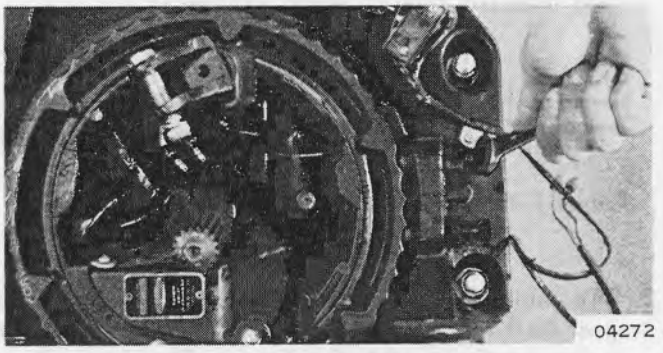

Figure 8. Tightening Locking Screws

TRANSOM PLATE INSTALLATION

Install washers and nuts on bolts and torque all 8 nuts evenly to 25-30 ft. lbs. (3.45-4.15mkg). (Figure 9)

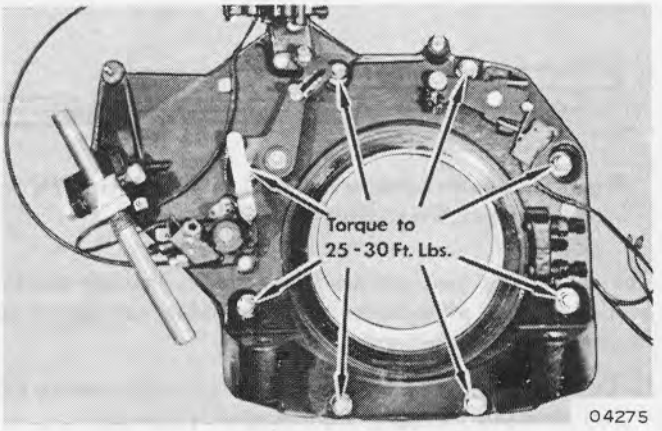

Figure 9. Transom Plate Installed

SHIFT CABLE INSTALLATION and ADJUSTMENT

Before proceeding with the following instructions, be certain that remote control, control cables and Power Shift unit installation is completed according to instructions on preceding pages.

IMPORTANT: Do not attach throttle cable to carburetor until after shift cable installation and adjustment is completed.

This stern drive unit is assembled so that the propeller shaft rotation is left hand (counterclockwise when viewed from rear) and must use a left hand propeller.

The propeller shaft rotation can be changed to right hand by following instructions outlined under III or IV, following, and installing a right hand propeller. When installing shift cables, it is very important that correct adjustments are made so that remote control station is synchronized with stern drive unit, and full clutch engagement is attained when remote control handle is in forward or reverse position.

SHIFT CABLE DIMENSIONS

To obtain maximum adjustability on remote control shift cable, drive unit shift cable dimensions must be checked as follows:

1. With cable end guide removed and unit in full reverse gear, inner core wire of stern drive unit shift cable must extend exactly 1-3/8" (34.9mm) from end of cable guide insert (full forward gear engagement on right hand propeller rotation units). (Figure 1)

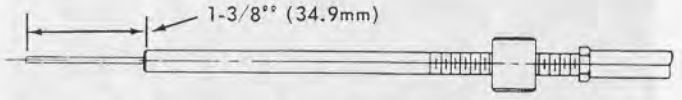

Figure 1. Inner Core Wire Extension Stern Drive Unit Shift Cable - Late Style

2. With cable end guide installed and unit in full forward gear (full reverse gear engagement on right hand propeller rotation units), the distance from center line of brass barrel to center line of cable end guide mounting hole must be exactly 7¾" (19.7cm). (Figure 2) Readjust brass barrel to achieve this dimension.

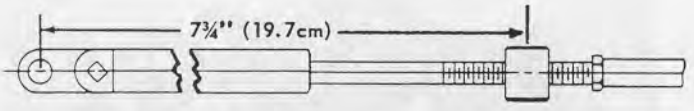

Figure 2. Center Line to Center Line Dimension 7¾" Stern Drive Unit Shift Cable

The following instructions individually outline the installation and adjustment of shift cables on the 4 following type installations:

I. Left hand propeller rotation drive unit with remote control mounted on right (starboard) side of boat.

II. Left hand propeller rotation drive unit with remote control mounted on left (port) side of boat.

III. Right hand propeller rotation drive unit with remote control mounted on right (starboard) side of boat.

IV. Right hand propeller rotation drive unit with remote control mounted on left (port) side of boat.

Select and follow instructions which apply to installation Type I, II, III or IV.

I. LEFT HAND PROPELLER ROTATION DRIVE UNIT

Remote Control Mounted on Right (Starboard) Side of Boat

FORWARD ADJUSTMENT

1. Fasten stern drive shift cable end guide to mounting stud in shift lever slot and place brass barrel in recess of cutout switch lever, retaining it with cotter key. (Figure 3)
2. Pull top of shift lever to left (when viewed from inside boat) as far as possible while turning propeller shaft clockwise (when viewed from behind boat) until it cannot be turned any further. This shifts stern drive unit into forward gear. (Figure 4) Proper engagement of clutch, as shown in Figure 5, will be felt.

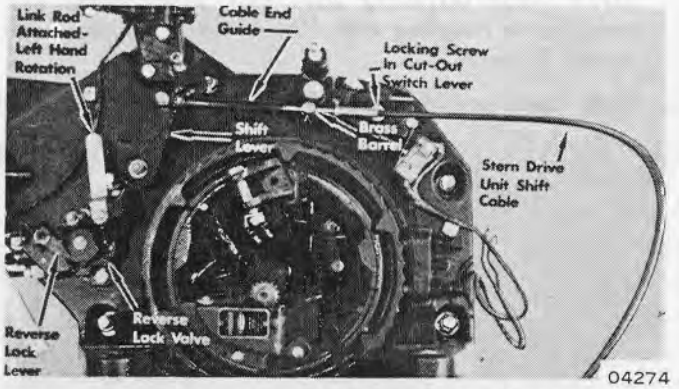

Figure 3. Installing Shift Cable End Guide and Brass Barrel

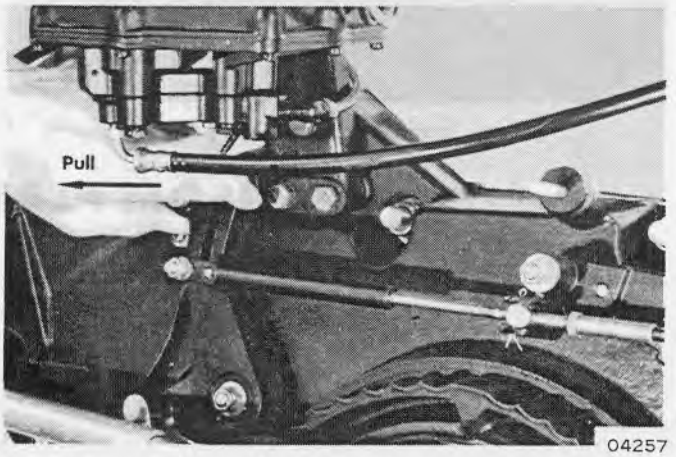

Figure 4. Manually Shifting into Forward Gear-LH Rotation - RH Control

Figure 5. Gear Clutch Engagement

NOTE: Be sure to pull lever to left as far as possible to ensure full engagement of clutch teeth. Operating unit with partial engagement of teeth will cause clutch teeth corners to round off and require replacement of sliding clutch and forward gear.

3. Move remote control handle to full forward.
4. Anchor remote control shift cable end guide to shift lever anchor stud with spacer, washer and nut. Pull outer conduit away from cable guide as far as possible to eliminate slack in cable and adjust brass barrel to align with transom mounting stud. (Figure 6)

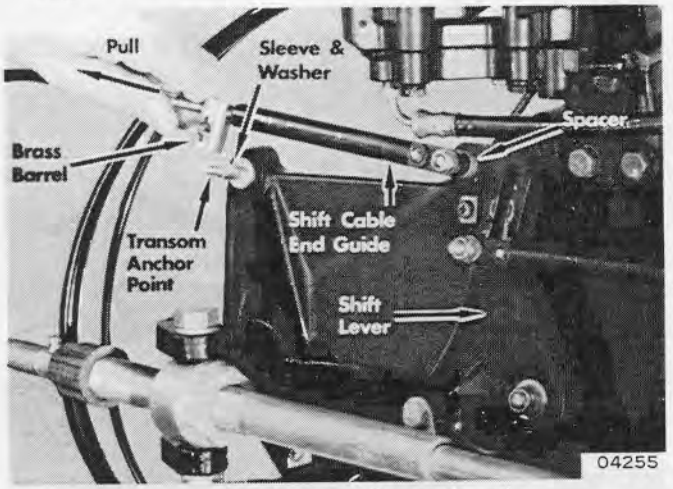

Figure 6. Adjusting Brass Barrel

5. Fasten brass barrel to transom anchor stud with sleeve washers and nut. The remote control and stern drive now are synchronized in "Forward" gear.

REVERSE ADJUSTMENT

1. Disconnect remote control shift cable end guide from shift lever.
2. Push top of shift lever to right (when viewed from inside boat) as far as possible while turning propeller shaft. (Figure 7) This shifts stern drive unit into reverse gear. Proper engagement of clutch, as shown in Figure 5, will be felt.

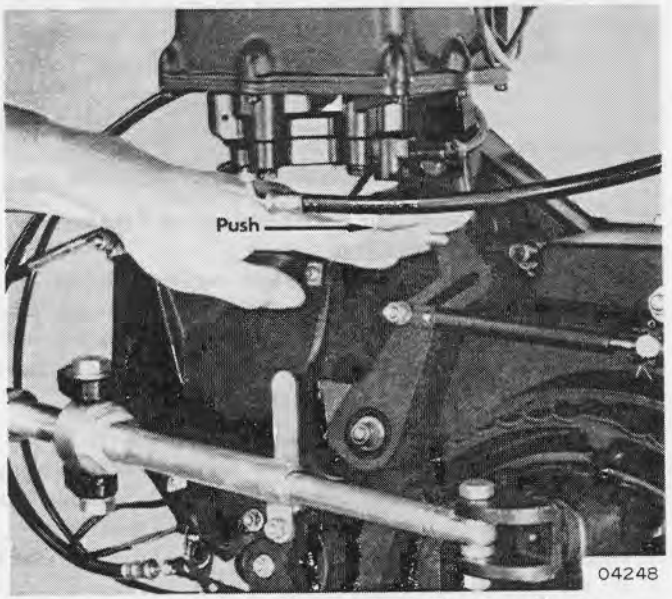

Figure 7. Manually Shifting into Reverse Gear - LH Rotation - RH Control

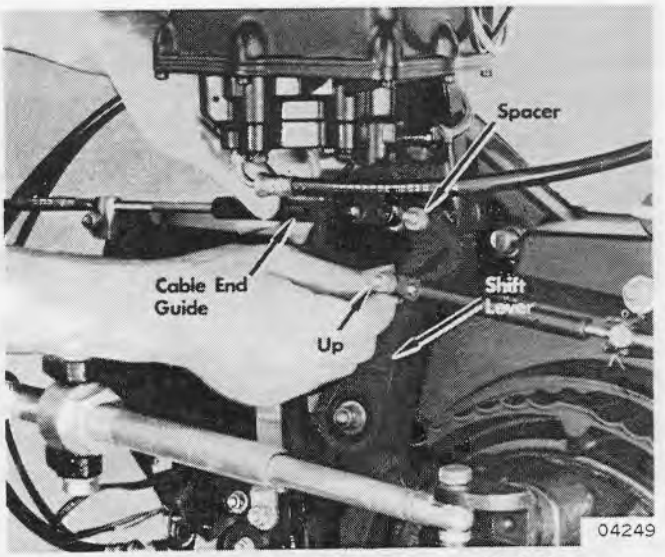

Figure 8. Reinstalling Shift Cable on Shift Lever

NOTE: Be sure to push lever to right as far as possible to ensure full engagement of clutch teeth. Operating unit with partial engagement of teeth will cause clutch teeth corners to round off and require replacement of sliding clutch and reverse gear.

3. Move remote control handle to full reverse.
4. Raise cable end guide of stern drive shift cable up slot in shift lever until remote control shift cable can be reinstalled on shift lever. (Figure 8)
5. Continue to slide cable guide end up slot until slack is removed from remote control shift cables. Tighten anchor stud and nut which fasten control cable guide end to shift lever.

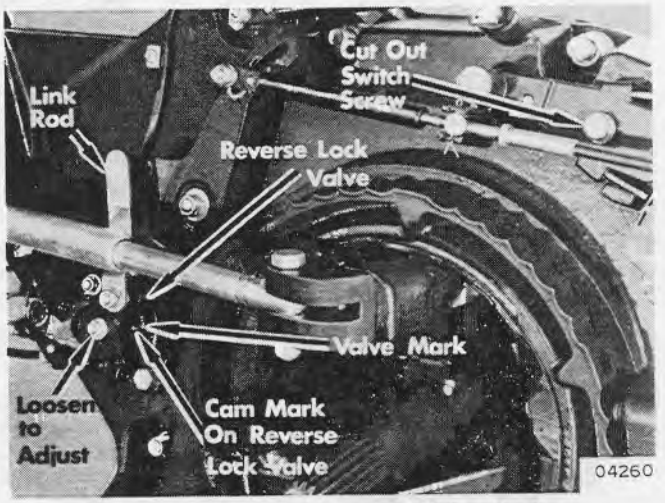

Figure 9. Aligning Cam and Valve Marks

6. Reverse lock adjustment
   a. With unit in full reverse, check for alignment of cam and valve marks. (Figure 9)
   b. If cam mark and valve marks do not align, loosen 2 nuts on reverse lock lever and move upper nut in direction required to line up raised triangular mark on reverse lock valve cover. Tighten 2 nuts on reverse lock lever.
7. Remove screw which extends thru shift cutout switch lever. (Figure 10)

Figure 10. Shift Cutout Switch Lever

8. This completes installation of shift cable.

II. LEFT HAND PROPELLER ROTATION DRIVE UNIT

Remote Control Mounted on Left (Port) Side of Boat

FORWARD ADJUSTMENT

1. Fasten stern drive shift cable end guide to mounting stud in shift lever slot and place brass barrel in recess of cutout switch lever, retaining it with cotter key. (Figure 3)
2. Pull top of shift lever to left (when viewed from inside boat) as far as possible while turning propeller shaft clockwise (when viewed from behind boat) until it cannot be turned any further. (Figure 4)

   This shifts stern drive unit into forward gear. Proper engagement of clutch, as shown in Figure 5, will be felt.

   NOTE: Be sure to pull lever to left as far as possible to ensure full engagement of clutch teeth. Operating unit with partial engagement of teeth will cause clutch teeth corners to round off and require replacement of sliding clutch and forward gear.
3. Move remote control handle to full forward.
4. Anchor remote control shift cable end guide to transom anchor stud with spacer, washer and nut. Push outer conduit away from cable guide as far as possible to eliminate slack in cable and adjust brass barrel to align with transom mounting stud. (Figure 11)

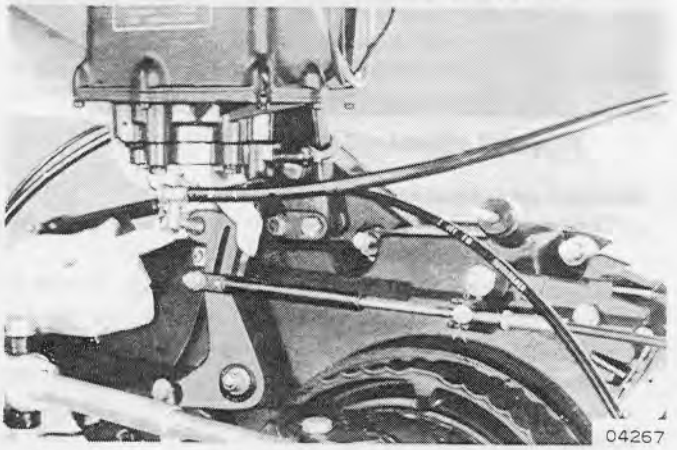

Figure 11. Adjusting Brass Barrel

5. Fasten brass barrel to shift lever stud with sleeve, washers and nut. The remote control and stern drive now are synchronized in "Forward" gear.

REVERSE ADJUSTMENT

1. Disconnect remote control cable end guide from transom anchor stud.
2. Push top of shift lever to right (when viewed from inside boat) as far as possible while turning propeller shaft. (Figure 12) This shifts stern drive unit into reverse gear. Proper engagement of clutch, as shown in Figure 5, will be felt.

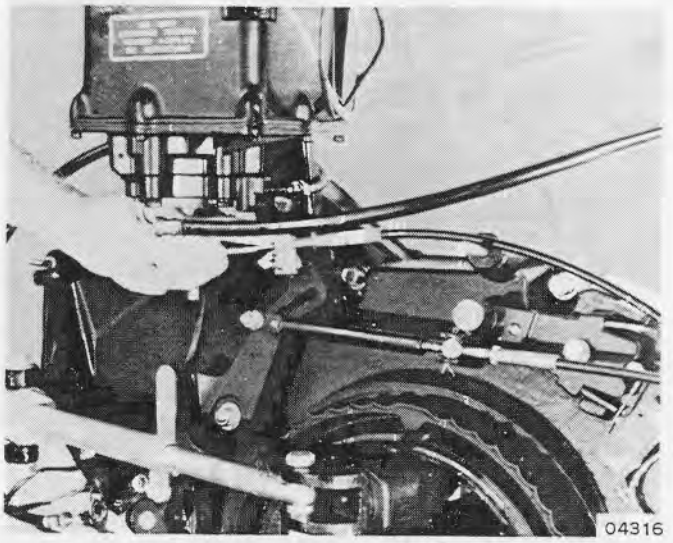

Figure 12. Shifting Stern Drive Unit into Reverse

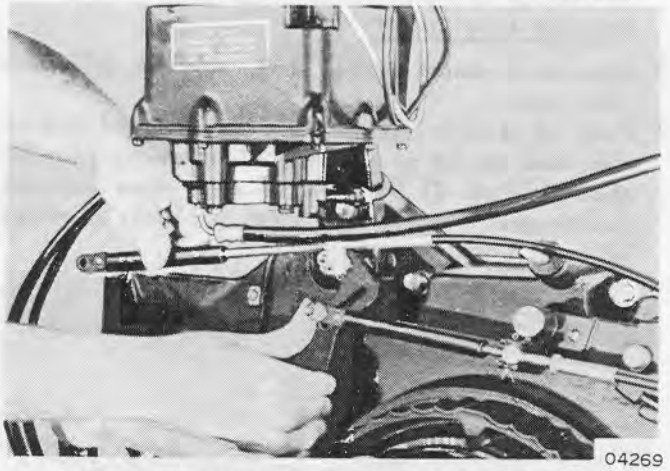

Figure 13. Shift Cable Reinstalled on Transom Anchor Stud

NOTE: Be sure to push lever to right as far as possible to ensure full engagement of clutch teeth. Operating unit with partial engagement of teeth will cause clutch teeth corners to round off and require replacement of sliding clutch and reverse gear.

3. Move remote control handle to full reverse.
4. Raise cable end guide of stern drive shaft cable up slot in shift lever until remote control shift cable can be reinstalled on transom anchor stud. (Figure 13)
5. Continue to slide cable guide end up slot until slack is removed from remote control shift cable. Tighten anchor stud and nut which fasten control cable guide end to shift lever.

6. Reverse lock adjustment
   a. With unit in full reverse, check for alignment of cam and valve marks. (Figure 9)
   b. If cam mark and valve marks do not align, loosen 2 nuts on reverse lock lever and move upper nut in direction required to line up raised triangular mark on reverse lock valve cover. Tighten 2 nuts on reverse lock lever.
7. Remove screw which extends thru shift cutout switch lever. (Figure 9)
8. This completes installation of shift cable.

III. RIGHT HAND PROPELLER ROTATION DRIVE UNIT

Remote Control Mounted on Right (Starboard) Side of Boat

Convert left hand rotation drive unit to right hand rotation by removing link rod end from reverse lock lever (Figure 14) and reinstall in opposite side of the lever. (Figure 15)

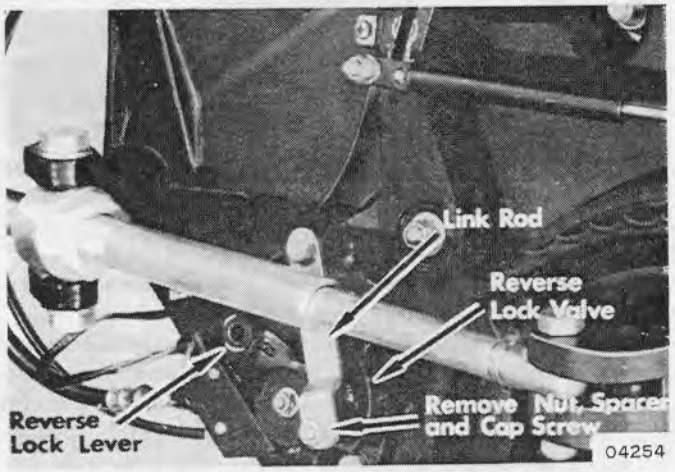

Figure 14. Removing Link Rod

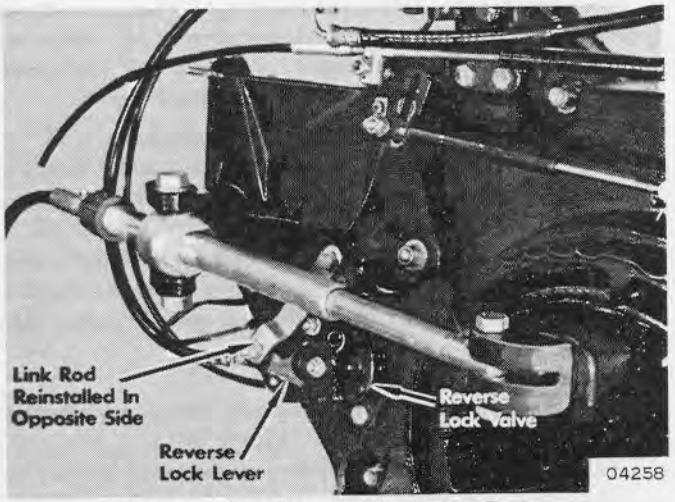

Figure 15. Reinstalling Link Rod

REVERSE ADJUSTMENT

1. Fasten stern drive shift cable end guide to mounting stud in shift lever slot and place brass barrel in recess of cutout switch lever, retaining it with cotter key. (Figure 3)
2. Pull top of shift lever to left (when viewed from inside boat) as far as possible while turning propeller shaft clockwise (when viewed from behind boat) until it cannot be turned any further. (Figure 4) Proper engagement of clutch, as shown in Figure 5, will be felt.

NOTE: Be sure to pull lever to left as far as possible to ensure full engagement of clutch teeth. Operating unit with partial engagement of teeth will cause clutch teeth corners to round off and require replacement of sliding clutch and reverse gear.

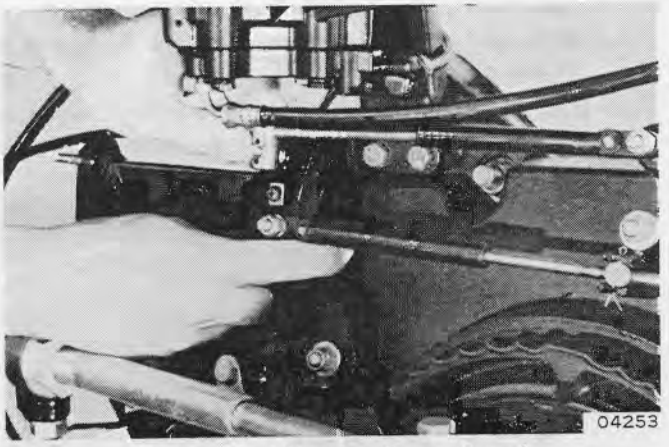

Figure 16. Adjusting Brass Barrel

3. Move remote control handle to full reverse.
4. Anchor remote control shift cable end guide to transom anchor stud with spacer, washer and nut. Pull outer conduit away from cable guide as far as possible to eliminate slack in cable and adjust brass barrel to align with shift lever mounting stud. (Figure 16)
5. Fasten brass barrel to shift lever stud with sleeve, washers and nut. The remote control and stern drive now are synchronized in "Reverse" gear.

FORWARD ADJUSTMENT

1. Disconnect remote control shift cable from shift lever.
2. Push top of shift lever to right (when viewed from inside boat) as far as possible while turning propeller shaft. (Figure 7) This shifts stern drive unit into "Forward" gear. Proper engagement of clutch, as shown in Figure 5, will be felt.

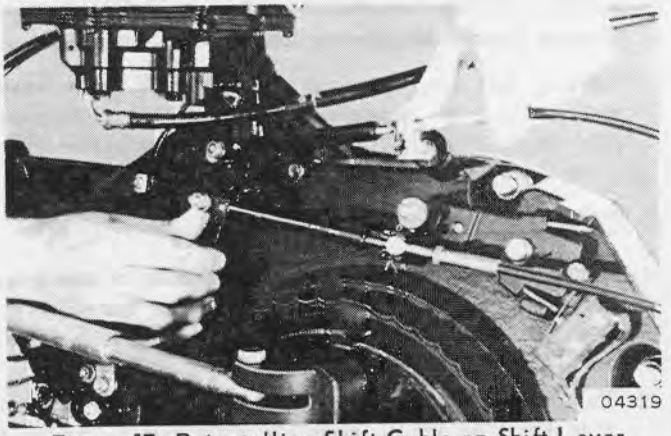

Figure 17. Reinstalling Shift Cable on Shift Lever

NOTE: Be sure to push lever to right as far as possible to ensure full engagement of clutch teeth. Operating unit with partial engagement of teeth will cause clutch teeth corners to round off and require replacement of sliding clutch and forward gear.

3. Move remote control handle into full forward.
4. Raise cable end guide of stern drive shift cable up slot in shift lever until remote control shift cable can be reinstalled on shift lever. (Figure 17)
5. Continue to slide cable guide end up slot until slack is removed from remote control shift cables. Tighten anchor stud and nut which fasten control cable guide end to shift lever.
6. Reverse lock adjustment
   a. Shift unit into full reverse and check for alignment of cam and valve marks. (Figure 18)

   NOTE: For proper link rod to reverse lock valve installation for right hand rotation, refer to Figures 14 and 15, preceding.

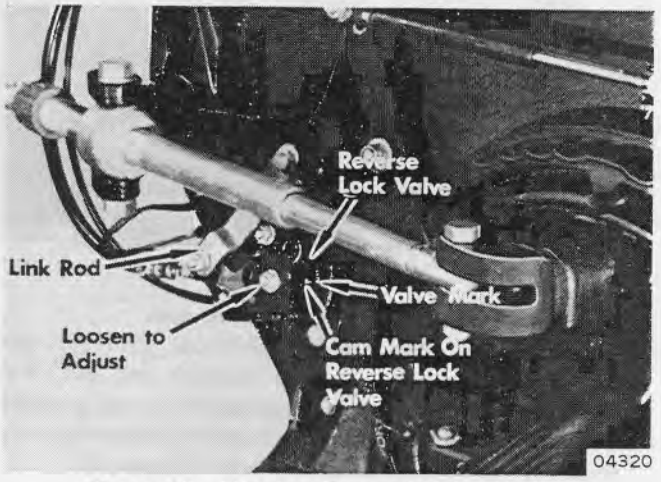

Figure 18. Aligning Cam and Valve Marks

   b. If cam mark and valve marks do not align, loosen 2 nuts on reverse lock lever and move upper nut in direction required to line up triangular mark on reverse lock valve cover. Tighten 2 nuts on reverse lock lever.
7. Remove screw which extends thru shift cutout switch lever. (Figure 17)
8. This completes installation of shift cable.

IV. RIGHT HAND PROPELLER ROTATION DRIVE UNIT

Remote Control Mounted on Left (Port) Side of Boat

Convert left hand rotation drive unit to right hand rotation unit by removing link rod end from reverse lock lever (Figure 14) and reinstall in opposite side of the lever. (Figure 15)

REVERSE ADJUSTMENT

1. Fasten stern drive shaft cable end guide to mounting stud in shift lever slot and place brass barrel in recess of cutout switch lever, retaining it with cotter key. (Figure 3)
2. Pull top of shift lever to left (when viewed from inside boat) as far as possible while turning propeller shaft clockwise (when viewed from behind boat) until it cannot be turned any further. (Figure 4) Proper engagement of clutch, as shown in Figure 5, will be felt.

   NOTE: Be sure to pull lever to left as far as possible to ensure full engagement of clutch teeth. Operating unit with partial engagement of teeth will cause clutch teeth corners to round off and require replacement of sliding clutch and reverse gear.
3. Move remote control handle to full reverse.
4. Anchor remote control shift cable end guide to shift lever stud with spacer, washer and nut. Pull outer conduit away from cable guide as far as possible to eliminate slack in cable and adjust brass barrel to align with transom anchor stud. (Figure 19)
5. Fasten brass barrel to transom anchor stud with sleeve, washers and nut. The remote control and stern drive now are synchronized in "Reverse" gear.

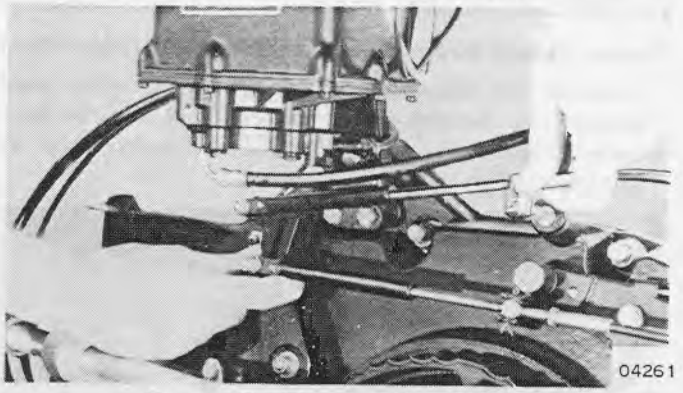

Figure 19. Adjusting Brass Barrel

FORWARD ADJUSTMENT

1. Disconnect remote control shift cable from transom anchor stud.
2. Push top of shift lever to right (when viewed from inside boat) as far as possible while turning propeller shaft. (Figure 7) This shifts stern drive unit into "Forward" gear. Proper engagement of clutch, as shown in Figure 5, will be felt.

   NOTE: Be sure to push lever to right as far as possible to ensure full engagement of clutch teeth. Operating unit with partial engagement of teeth will cause clutch teeth corners to round off and require replacement of sliding clutch and forward gear.
3. Move remote control handle into full forward.
4. Raise cable end guide of stern drive shift cable up slot in shift lever until remote control shift cable can be reinstalled on transom anchor point. (Figure 17)
5. Continue to slide cable guide end up slot until slack is removed from remote control shift cables. Tighten anchor stud and nut which fasten control cable guide end to shift lever.
6. Reverse lock adjustment
   a. Shift unit into full reverse and check for alignment of cam and valve marks. (Figure 18)

   NOTE: For proper link rod to reverse lock valve installation for right hand rotation, refer to Figures 3 and 4, preceding.

   b. If cam mark and valve marks do not align, loosen 2 nuts on reverse lock lever and move upper nut in direction required to line up triangular mark on reverse lock valve cover. Tighten 2 nuts on reverse lock lever.
7. Remove screw which extends thru shift cutout switch lever. (Figure 10)
8. This completes installation of shift cable.

THROTTLE CONTROL CABLE ATTACHMENT

1. Fasten throttle cable to side and transom of boat with clips to form a gradual bend leading to throttle lever linkage.
2. Place remote control handle in neutral and neutral warmup lever down before attaching cable.

   NOTE: If knurled pin is in cable guide end, remove pin and spring.

3. Remove nut and one washer from screw which passes thru carburetor throttle lever.
4. Place cable end guide over spacer. Place flat washer and nut on screw and tighten nut securely. (Figure 1 and 2)

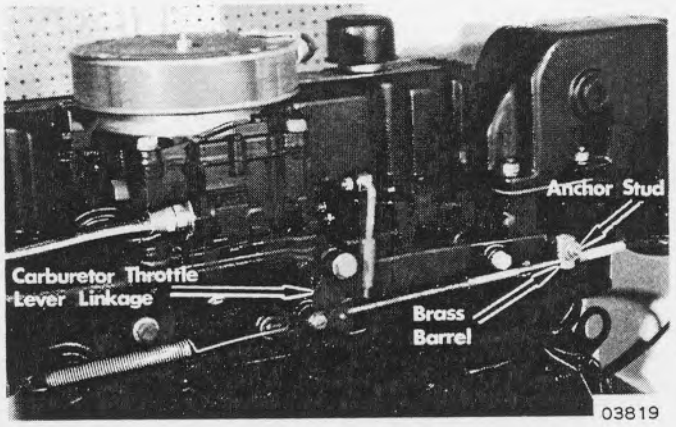

Figure 1. Throttle Cable Installed - "200"

5. Grasp throttle cable behind brass barrel and push toward throttle arm.
   Adjust brass barrel to align with anchor stud in bracket. Place flat washer, sleeve and barrel on stud.
   Place flat washer and stop nut on stud and tighten nut securely. (Figure 1 and 2)
6. Check that primary throttle valves are fully open when remote control handle is all the way forward.
7. Set engine idle speed at 500-600 RPM in forward gear by adjusting idle stop screw on carburetor. Turn screw in to increase RPM; back screw out to decrease RPM.

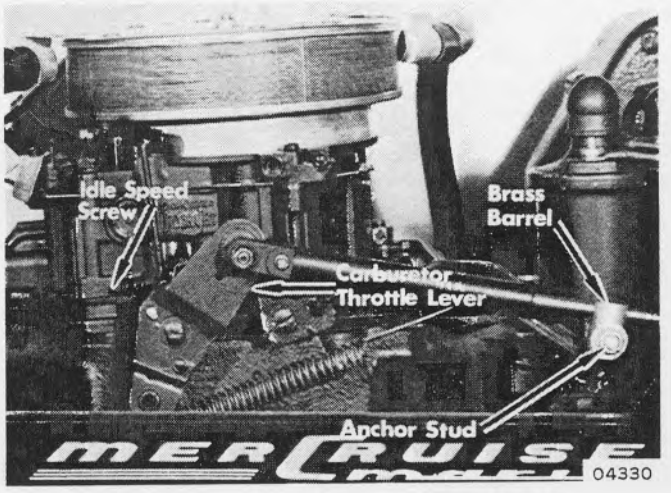

Figure 2. Throttle Cable Installed - "225"

SECTION 2 - REMOVAL, INSTALLATION and ALIGNMENT

MERCRUISER

PART E - MERCRUISER III STERN DRIVE

MERCURY MARINE

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MERCRUISER III ENGINE REMOVAL

NOTE: Stern drive unit must be removed prior to engine removal.

1. Disconnect battery cables from battery and remove instrument panel harness connector plug from engine harness receptacle.
2. Disconnect fuel line, throttle and shift control.
3. Disconnect reverse lock switch wire, hydraulic pump motor and trim indicator wires from engine.
4. Remove water inlet tube and exhaust tubes.
5. Support engine with a suitable sling thru lifting eyes on engine and remove front and rear engine mounting bolts. (Figure 1)
6. Remove engine.

ENGINE INSTALLATION and ALIGNMENT

NOTE: Prior to installing engine, transom plates and Ride-Guide Steering must be installed as outlined in "Stern Drive Unit Installation Manual" (C-90-48375).

1. Place one large steel washer, one double-wound lock washer and one neoprene washer on top of each inner transom plate engine support. (Figure 1)
2. Coat large "O" ring seal, which is located as shown in Figure 2, with New Quicksilver Multipurpose Lubricant (C-92-49588).
3. Lift engine with an overhead hoist, using a suitable sling and lifting eyes on engine.

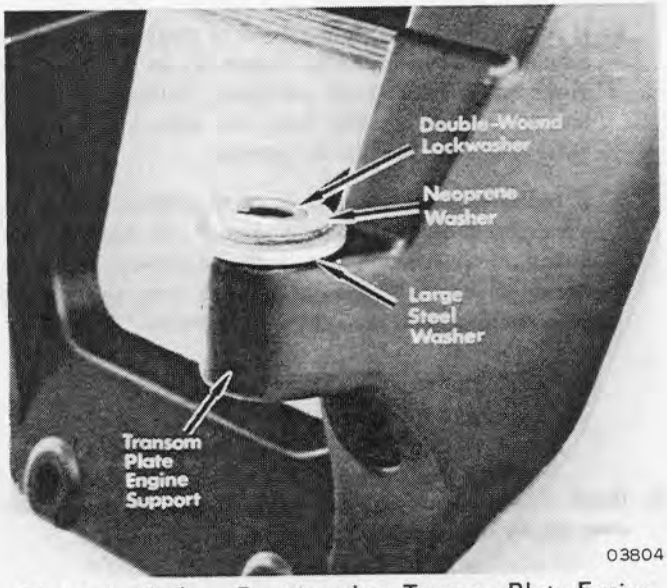

Figure 1. Washers Positioned on Transom Plate Engine Support

4. Position engine ahead of inner transom plate so that bearing support housing and "O" ring seal (Figure 2) are in line with large opening in inner transom plate.
5. Move engine toward inner transom plate and, at the same time, guide bearing support housing into transom plate opening. Be careful that "O" ring seal does not become damaged. Continue to move engine toward inner plate until holes in rear engine mounts line up with holes in washers and transom plate engine supports.
6. Relieve hoist tension, as required, to allow rear engine mounts to rest on transom plate engine supports and washers.

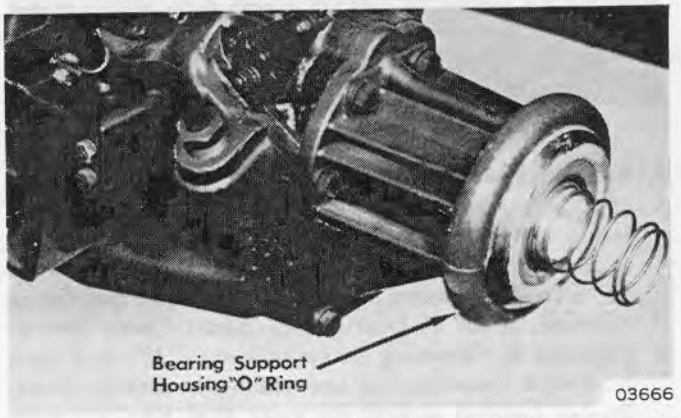

Figure 2. Bearing Support Housing and "O" Ring

IMPORTANT: Do not relieve hoist tension entirely at this time, as rear engine mounts and bearing support housing may be damaged.

7. Insert rear engine mount bolts up thru transom plate, washers and rear engine mounts. Place one neoprene washer and one small steel washer on each mount bolt. Thread elastic stop nut on each bolt and torque nut to 100 ft. lbs. (13.8mkg). (Figure 3)

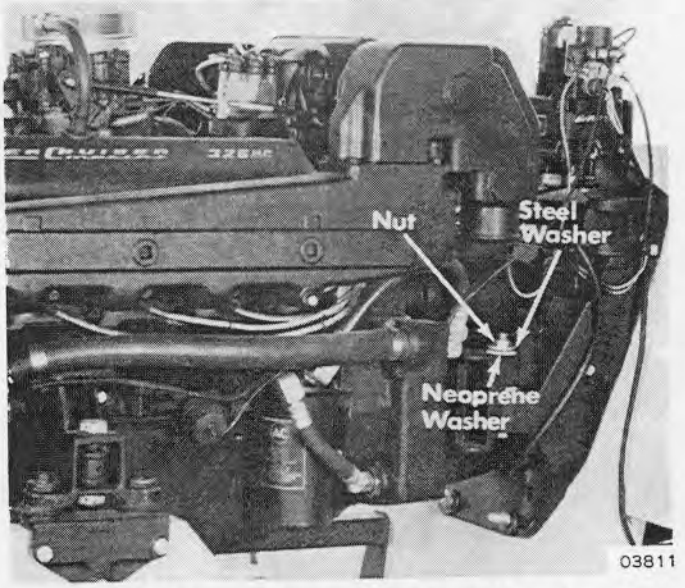

Figure 3. Rear Engine Mount Parts Location

8. Raise or lower front of engine with hoist, as required, to allow alignment rod to be positioned in recess located in inner transom plate and recess located in flywheel housing. (Figure 4)

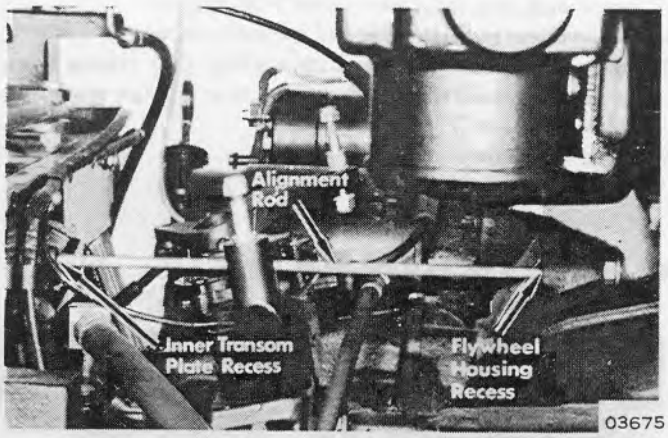

Figure 4. Alignment Rod Position

9. With alignment rod in position and engine supported with hoist, as outlined in preceding Step 8, front mount stringers should be constructed so that front engine mount bases will rest on top of stringers without disturbing engine alignment when hoist tension is relieved. Width of front engine mount bases can be adjusted by loosening screw and nut "A" in Figure 5 on each mount bracket and sliding mounts in or out. Do not position mounts out away from brackets more than 3/4" (19mm), as shown in Figure 5.

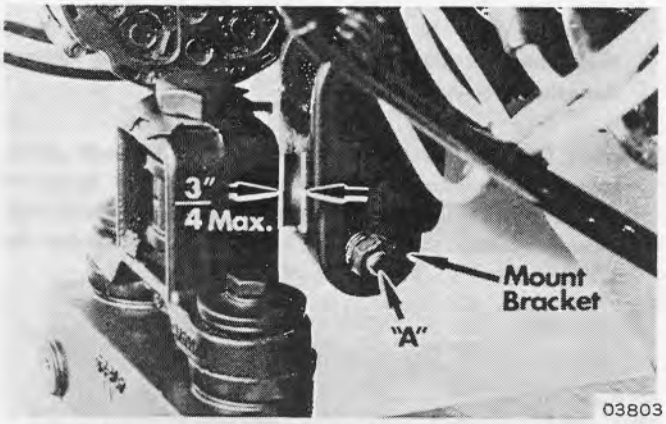

Figure 5. Maximum Front Mount Extension

10. Relieve hoist tension entirely. Fasten each mount base securely to stringer with three 3/8" dia. bolts, washers and locknuts. (Figure 6)
11. Check engine alignment rod fit. Rod should just fit in recesses in inner transom plate and flywheel housing. Rod should not have any fore-and-aft movement but should not be so tight that it cannot be removed by hand.

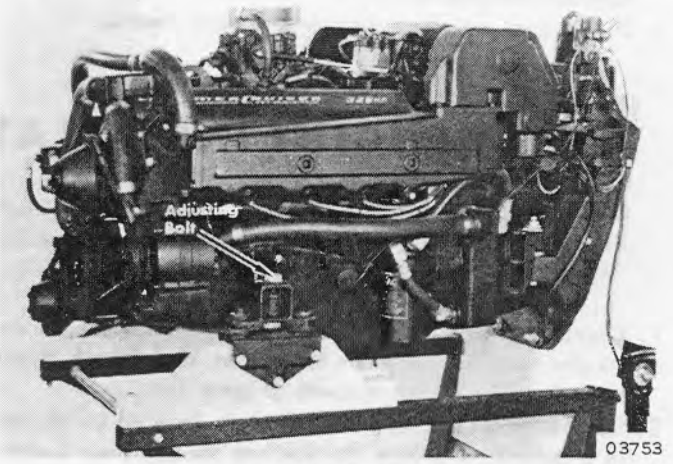

Figure 6. Engine Installed

12. If alignment rod fit is not as described in preceding Step 11, proceed as follows:

    a. If rod is too loose, raise front of engine by turning adjusting bolt, shown in Figure 6, on both mounts clockwise. Turn both adjusting bolts an equal amount by alternating from one side to the other until alignment rod fit is correct.

    b. If rod is too tight, lower front of engine by turning adjusting bolt, shown in Figure 6, on both mounts counterclockwise. Turn both adjusting bolts an equal amount by alternating from one side to the other until alignment rod fit is correct.

    "250" Alignment Rod B-47457 - 9.775" ±.010"
    "325" Alignment Rod B-47458 - 10.712" ±.010"
    (1" = 25.4mm [metric])

13. Bend tabs of mount adjusting bolt tab washers down over edges of mounts.

INSTALLING STERN DRIVE UNIT

(For Removal - Reverse the Following Procedure)

1. Lubricate land on drive shaft housing pilot (Figure 7) and drive shaft splines with New Multipurpose Lubricant (C-92-49588). Apply light coating of lubricant to inside surfaces of bell housing bore.
2. Check that "O" rings stay seated in grooves for sealing, or leakage will result. (Figure 7)

   NOTE: Use hoisting equipment to hold drive during installation.

3. Insert stern drive unit into drive shaft housing bell bore (Figure 8) by guiding drive shaft thru guide spring in engine drive coupling. If drive shaft splines do not align with engine coupling splines, rotate propeller shaft in either direction slightly until drive unit can be pushed into position. Propeller should be placed on shaft for easier rotation.
4. Fasten drive shaft housing to bell mounting bolts with 6 elastic stop nuts and flat washers. Tighten evenly to 100 ft. lbs. (6.9mkg) torque. Refer to Figure 8.

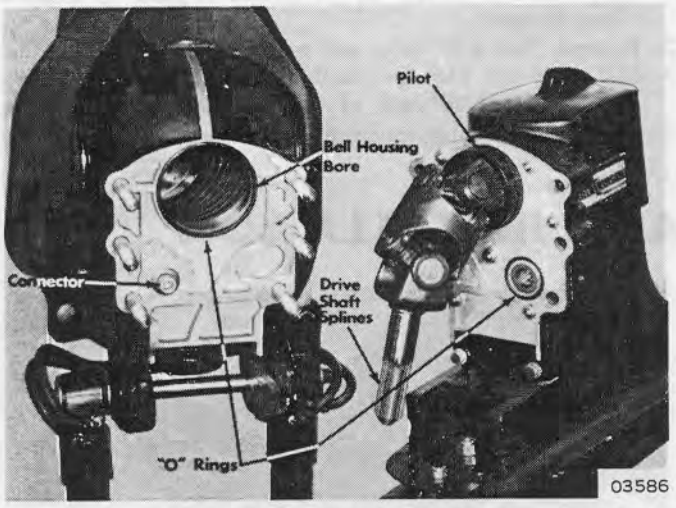

Figure 7. "O" Ring Positions

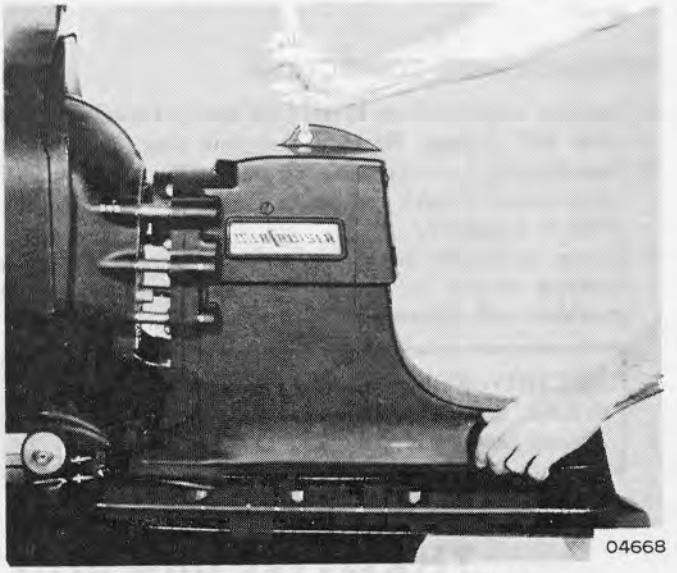

Figure 8. Inserting Unit into Bell Bore

TRANSOM PLATE INSTALLATION

1. Place transom gasket on gimbal housing assembly and set assembly and inner transom plate in position over openings in transom as follows:
   a. Insert switch lead, hydraulic hoses and unit oil hose thru opening in transom and place gimbal housing in position.
   b. While holding gimbal housing in this position, insert switch lead, hydraulic hoses and unit oil hose thru large opening in inner transom plate and set in position. (Figure 9)
2. Fasten gimbal housing assembly and inner transom plate to transom.
   a. Place flat washers on studs, protruding thru inner transom plate, and thread on 6 elastic stop nuts.
   b. Insert 2 carriage bolts, with rubber seals under heads, thru bottom 2 holes of gimbal housing, transom and inner transom plate.

   CAUTION: Do not attempt to drive cap screws thru transom, as threads in gimbal housing will be damaged.

   c. Place flat washers on bolts and thread on 2 elastic stop nuts.

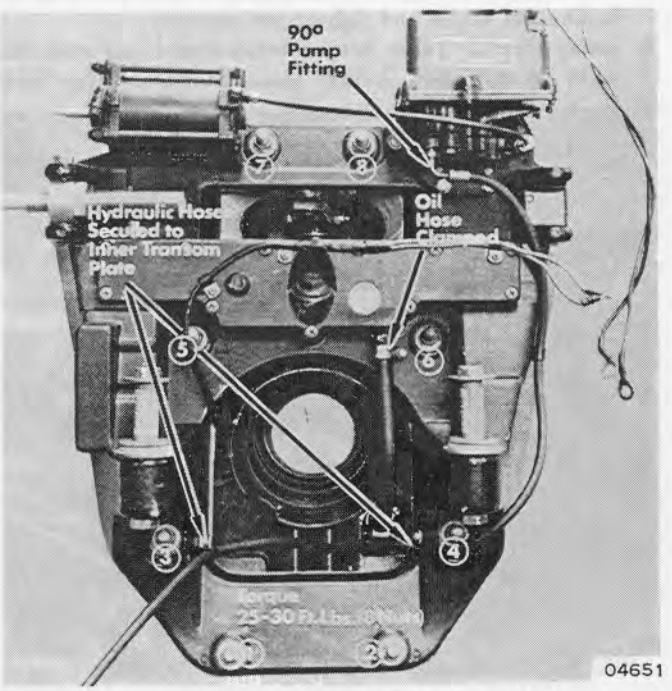

Figure 9. Inner Transom Plate Installed

3. Tighten elastic stop nuts evenly and torque to (25-30 ft. lbs. (3.45-4.14mkg).

IMPORTANT: Be certain that rubber seals stay seated in groove to properly seal joint, or leakage will result.

HYDRAULIC HOSE CONNECTIONS

1. Remove cap which is located on end of hydraulic hose with 90° fitting. Remove threaded plug from pump.
2. Immediately connect hose to pump. DO NOT ALLOW oil to run out of hose and pump. Tighten fitting securely. Refer to Figure 9.
3. Clamp hydraulic hoses securely to transom plate at location shown in Figure 9. Use clamp and screw provided with transom plate.

CAUTION: Failure to secure hoses may cause hydraulic hoses to become damaged and render system inoperative.

Hydraulic hose with 90° fitting is secured to port side of inner transom plate, and hose with straight fitting is secured to starboard side of inner transom plate. (Figure 9)

NOTE: Refer to engine installation manual for connection of hydraulic hoses to reverse lock valve and to hydraulic trim sender and for reverse lock valve adjustment. Early models were not equipped with trim sender.

SECURING DRIVE OIL HOSE AND FILLING RESERVOIR

1. Loosen clamp on drive oil hose, remove plug and connect hose to fitting on reservoir. (Figure 9) Tighten clamp securely.
2. Remove "oil fill" plug and sealing gasket.
3. Fill reservoir with Quicksilver Super-Duty Gear Lubricant (C-92-52655) until oil reaches level line on gauge.
4. Replace filler plug and sealing gasket.

THROTTLE and SHIFT CABLE INSTALLATION

Before proceeding with the following instructions, install remote control and throttle and shift cables, as outlined in the instructions which accompany the remote control.

THROTTLE CABLE (Figure 10)

1. Place remote control handle in neutral and neutral warmup lever down before attaching cable.
2. Remove roll pin, which passes thru knurled pin in cable end guide and remove knurled pin and spring.
3. Remove nut and one washer from screw which passes thru carburetor throttle lever.
4. Place cable end guide over spacer. Place flat washer and nut on screw and tighten nut securely.
5. Grasp throttle cable behind brass barrel and push toward throttle arm. Adjust brass barrel to align with anchor stud in bracket. Place flat washer, sleeve and barrel on stud. Place flat washer and stop nut on stud and tighten nut securely.

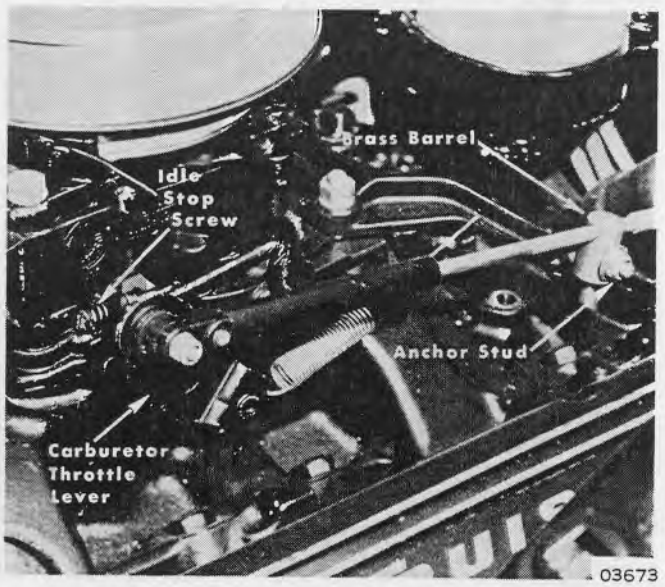

Figure 10. Throttle Cable Installation

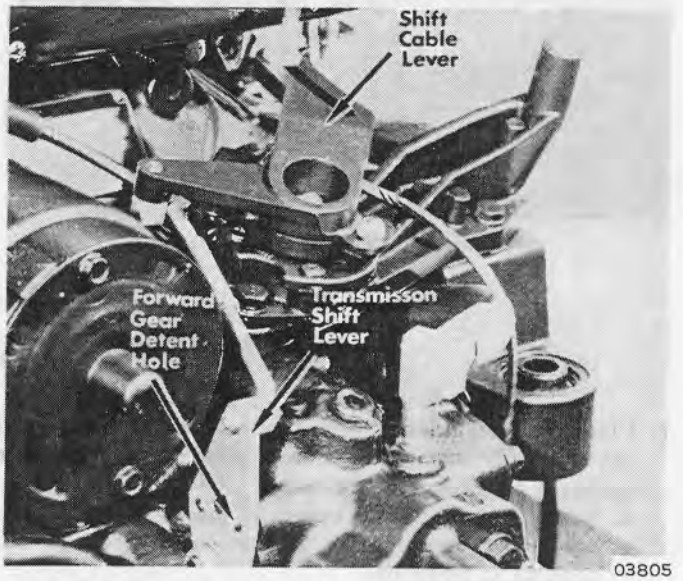

Figure 11. Transmission Shift Lever Position - Forward Gear

SHIFT CABLE

1. Place remote control handle in full forward position.
2. Place transmission in forward gear by moving shift cable lever to the right until detent ball, which is located behind transmission shift lever, is positioned in rear hole in transmission shift lever. (Figure 11)
3. Remove roll pin, which passes thru knurled pin in cable end guide, and remove knurled pin and spring from end guide.
4. Place cable end guide on stud which is located in shift cable lever. (Figure 12)

5. Adjust brass barrel on shift cable so that barrel can be placed on anchor stud without disturbing shift cable lever position. (Figure 12)
6. Fasten end guide to shift cable lever stud with flat washer and nut. Tighten nut and then back nut off slightly to allow end guide to pivot freely. (Figure 12)
7. Fasten brass barrel to anchor stud with flat washer and nut. Tighten nut securely. (Figure 12)
8. Place remote control handle in full reverse position.
9. Loosen nut which fastens stud to shift cable lever. Move shift cable lever to the left, while sliding stud down slot in lever, until detent ball is centered in front hole in transmission shift lever. Tighten nut securely. (Figure 13)

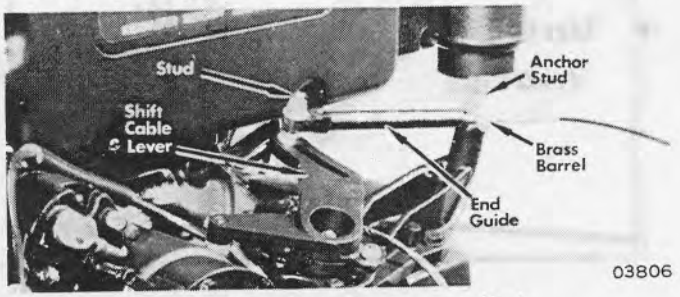

Figure 12. Shift Cable Installed

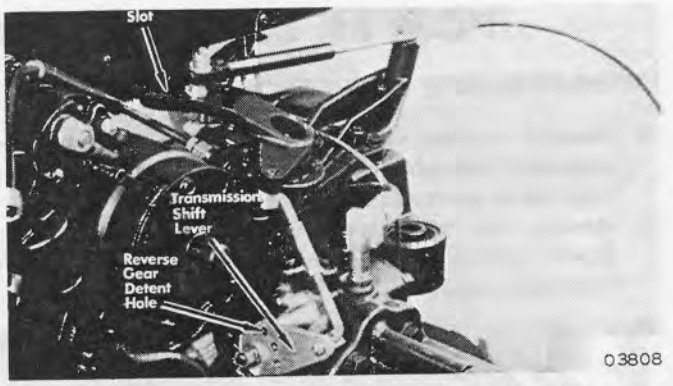

Figure 13. Transmission Shift Lever Position - Reverse Gear

10. Check adjustment by moving remote control handle to full forward. Detent ball must be centered in rear hole in transmission shift lever. (Figure 11) Move control handle to full reverse position. Detent ball must be centered in front hole in transmission shift lever. (Figure 13)) If transmission shift lever is not positioned correctly and does not permit detent ball to be centered in holes, as described previously, readjust cable.

INSTALLING COMBINATION TRIM and SHOCK CYLINDERS

NOTE: Refer to MerCruiser Service Manual for hydraulic system checks and tests.

1. Insert forward anchor pin thru anchor pin holes in gimbal ring.
2. Place one flat washer and one rubber washer on forward anchor pin on each side of gimbal ring.
3. Insert aft anchor pin thru hole in drive shaft housing and place a large washer and rubber bushing on aft anchor pin on each side of drive shaft housing. (Figure 14)
4. Place cylinders in position on forward and aft anchor pins. Be sure that one small spiral spring is installed between rubber bushings on each side of each pin. (Figure 14)

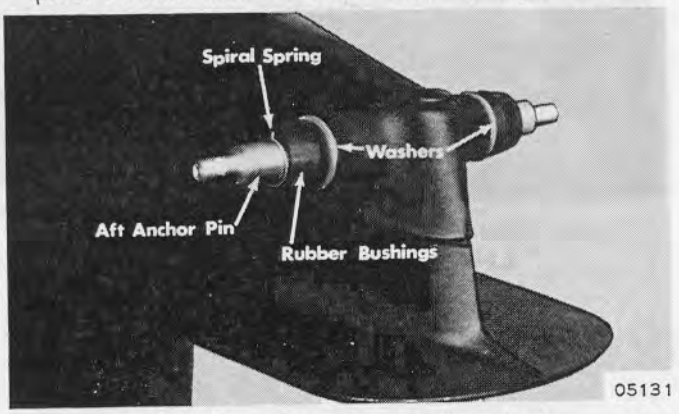

Figure 14. Aft Anchor Pin Installed

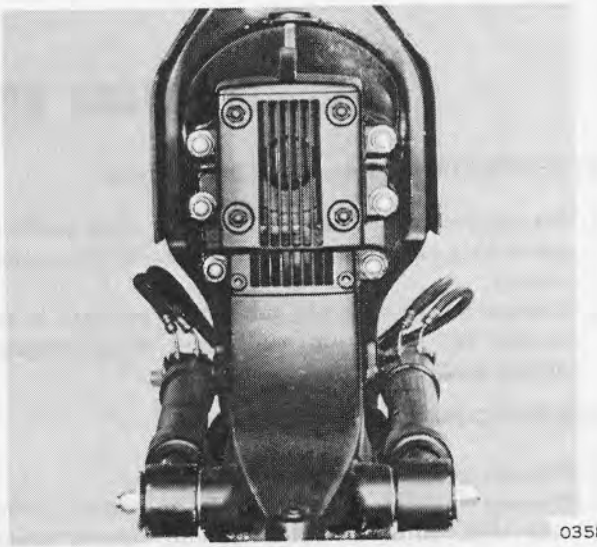

Figure 15. Drive and Trim Cylinders Installed

5. Place one rubber bushing in forward and aft end mounting of each cylinder. Small diameter end of bushings face drive shaft housing.
6. Place one flat washer on each end of both cylinders next to rubber bushings. Thread nuts on anchor pins and tighten securely. (Figure 15)

POWER TRIM HOSE and REVERSE LOCK VALVE

POWER TRIM HOSE CONNECTION

1. Remove cap from straight fitting, which is located on starboard hydraulic hose, and connect fitting to reverse lock valve as shown in Figure 1.
2. Remove cap from fitting, which is located on short, plastic hydraulic hose, and connect fitting to reverse lock valve as shown in Figure 1.

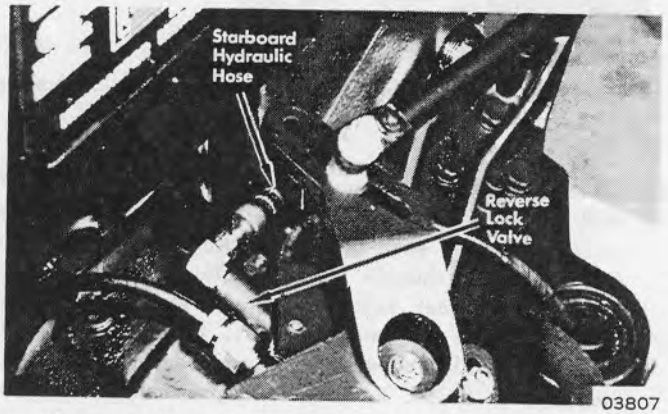

Figure 1. Hose Connections - Reverse Lock Valve

REVERSE LOCK VALVE ADJUSTMENT

1. Shift unit into full reverse; transmission shift lever in reverse detent.
2. Loosen 2 nuts on reverse lock lever and move upper nut in direction required to line up raised triangular mark on cam with raised triangular mark on reverse lock valve cover. (Figure 2) Tighten 2 nuts on shift lever.

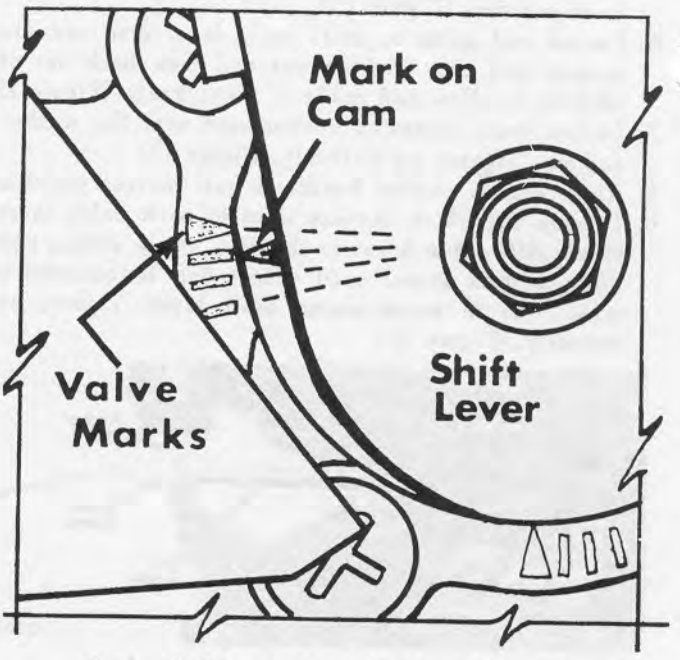

Figure 2. Reverse Lock Valve Adjustment

RIDE-GUIDE STEERING INSTALLATION

STEERING SWIVEL (Starboard Installation)

1. Steering swivel is mounted with the cable guide tube and locking nut installed to the outside of the steering swivel.
2. Loosen locking nut, turn guide tube out until it can be rotated 180°, then turn guide tube in and temporarily secure locking nut.

STEERING SWIVEL (Port Installation)

1. Remove guide tube and locking nut.
2. Remove pivot bolt, swivel pin in bottom of swivel ring with small drift by applying upward pressure.
3. Transfer swivel ring and 2 washers to port steering pivot.
4. Install steering swivel parts in reverse of disassembly. Refer to Figure 3.

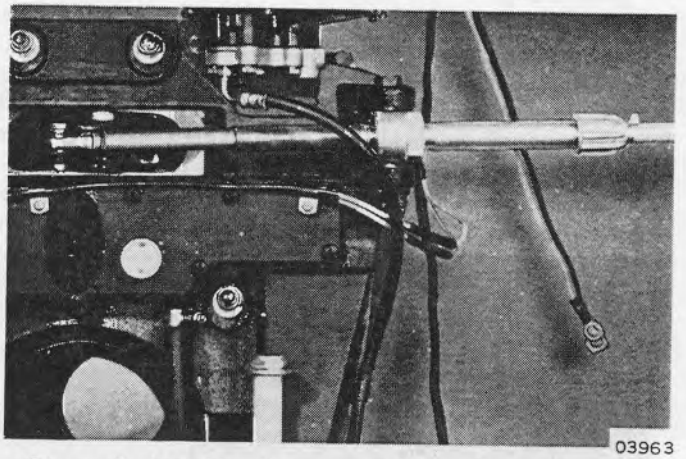

Figure 3. Attaching Steering Cable to Drive Unit from Left

SECTION 2-REMOVAL, INSTALLATION and ALIGNMENT

MERCRUISER

PART F - 215-H STERN DRIVE

MERCURY MARINE

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MERCRUISER 215-H ENGINE REMOVAL

NOTE: Stern drive unit must be removed prior to engine removal, if engine cannot be moved forward sufficiently to clear universal joint shaft. Stern drive removal is the reverse of installation.

1. Disconnect battery cables from battery and remove instrument panel harness connector plug from engine harness receptacle.
2. Disconnect fuel line, throttle and shift control cables.
3. Disconnect reverse lock switch wires, trim indicator switch wires and hydraulic pump wires from engine.
4. Remove water inlet tube and exhaust tubes.
5. Support engine with a suitable sling thru the lifting eyes on engine and remove front and rear engine mounting bolts.
6. Remove engine.

ENGINE INSTALLATION and ALIGNMENT

1. Place one steel washer, one double-wound lockwasher and one neoprene washer on top of each inner transom plate engine support. (Figure 1)

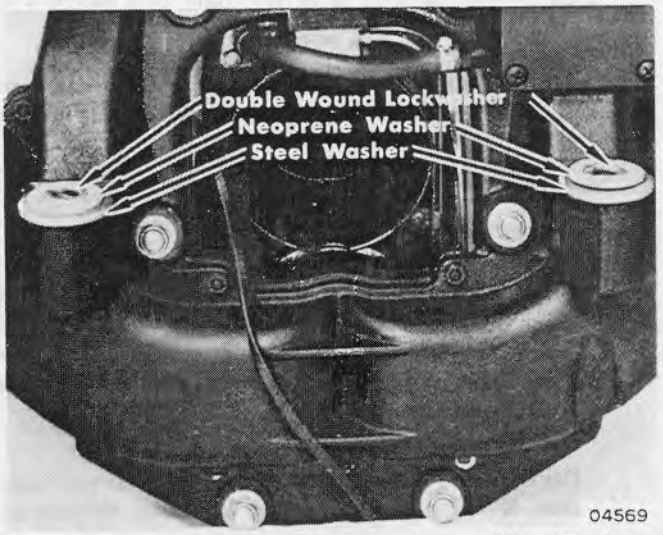

Figure 1. Washers Positioned on Transom Plate Engine Support

2. Coat "O" ring seal, located as shown in Figure 2, with New Multipurpose Lubricant (C-92-49588).

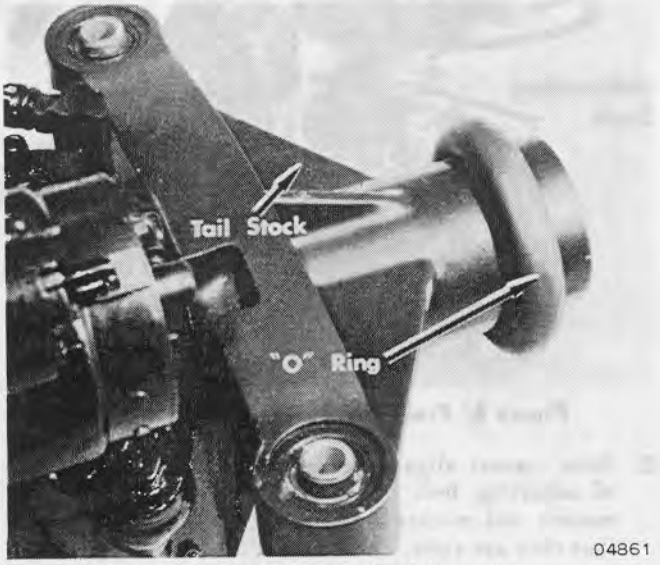

Figure 2. "O" Ring Seal Location

3. Lift engine with an overhead hoist, using a suitable sling and lifting eyes on engine.
4. Position engine ahead of inner transom so that tail stock and "O" ring seal (Figure 2) are in line with large opening in inner transom plate.
5. Move engine toward inner transom plate and, at the same time, guide tail stock into transom plate opening. Be careful that "O" ring seal does not become damaged. Continue to move engine toward inner plate until holes in rear mounts line up with holes in washers and transom plate engine supports.
6. Relieve hoist tension, as required, to allow rear engine mounts to rest on transom plate engine supports and washers.

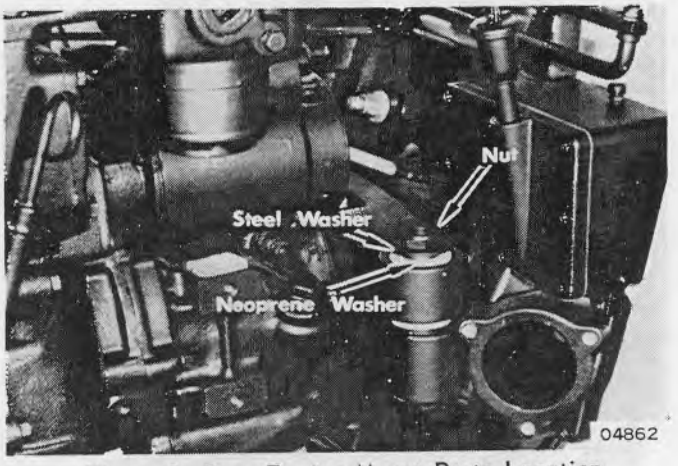

Figure 3. Rear Engine Mount Parts Location

IMPORTANT: DO NOT relieve hoist tension entirely at this time, as rear engine mounts and/or tail stock may be damaged.

7. Insert rear engine mount bolts up thru transom plate, washers and rear engine mounts. Place one neoprene washer and one steel washer on each mount bolt. Thread elastic stop nut on each bolt and torque nut to 100 ft. lbs. (13.8mk g). (Figure 3)
8. Insert end of Alignment Tool Shaft (C-91-57797A1), which has threaded hole, thru opening in bell housing into engine coupling. Insert shaft until it bottoms out in coupling. (Figure 4)

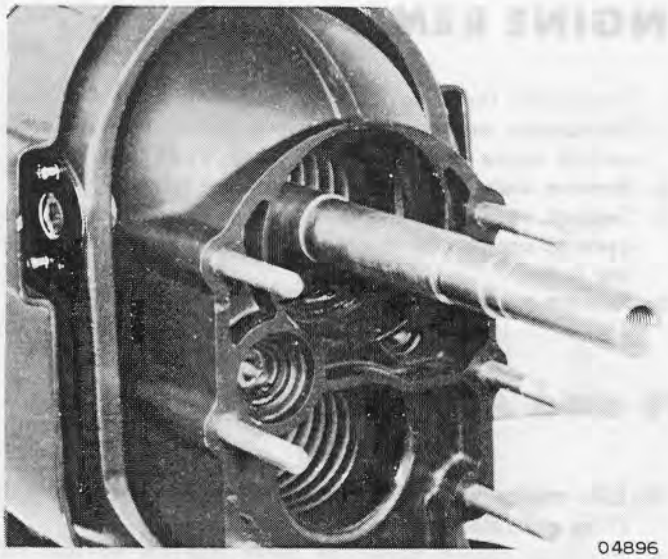

Figure 4. Alignment Shaft Installed

9. Position alignment tool plate on shaft, as shown in Figure 5, and slide plate toward bell housing. Raise or lower front of engine with hoist to allow shoulder on plate to enter bell housing opening.

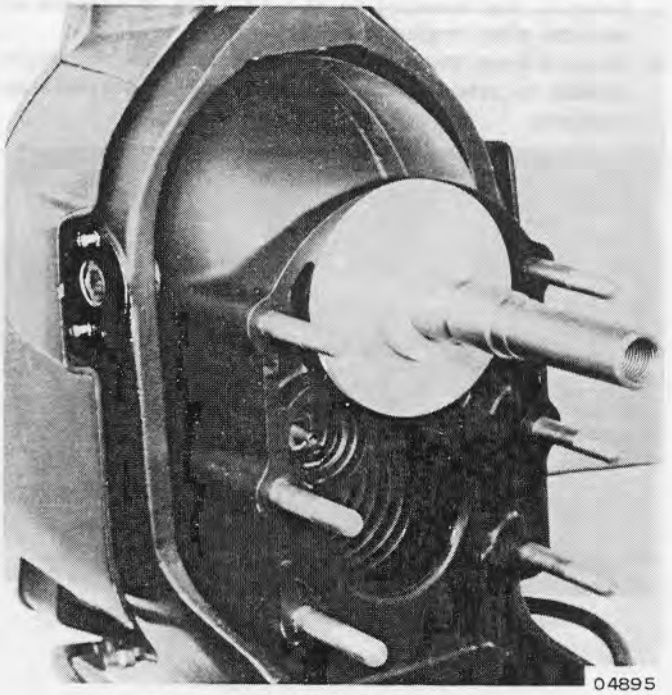

Figure 5. Tool Plate Installed

10. With alignment tool plate positioned in bell housing and engine supported with hoist, front engine mount supports should be constructed so that mounts will rest on top of supports without disturbing alignment tool plate position when hoist tension is relieved.
11. Relieve hoist tension entirely and fasten front mount bases to supports with 3/8" dia. bolts, washers and locknuts.
12. Push alignment shaft and plate toward engine and, while holding plate against bell housing, check for gap between plate and rear surface of bell housing at 12, 3, 6 and 9 o'clock positions. Engine alignment is correct when there is no gap at any point. If gap exists, proceed as follows:

GAP at 12 O'CLOCK POSITION

Raise front of engine by turning adjusting bolt on both front mounts clockwise. (Figure 6) Turn bolts an equal amount by alternating from one side to the other until gap no longer exists.

GAP at 6 O'CLOCK POSITION

Lower front of engine by turning adjusting bolt on both front mounts counterclockwise. (Figure 6) Turn both bolts an equal amount by alternating from one side to the other until gap no longer exists.

GAP at 3 O'CLOCK POSITION

a. Loosen screw and nut ("A" in Figure 6) on both front mounts.
b. Loosen both rear mount bolts 2 turns.
c. Move front of engine to the right (starboard) until gap no longer exists.

IMPORTANT: Mounts must not extend out more than ¾" (19mm) from mount brackets. (Figure 6)

d. Tighten all mount fasteners securely.

GAP at 9 O'CLOCK POSITION

a. Loosen screw and nut ("A" in Figure 6) on both front mounts.
b. Loosen both rear mount bolts 2 turns.
c. Move front of engine to the left (port) until gap no longer exists.

IMPORTANT: Mounts must not extend out more than ¾" (19mm) from mount brackets. (Figure 6)

d. Tighten all mount fasteners securely.

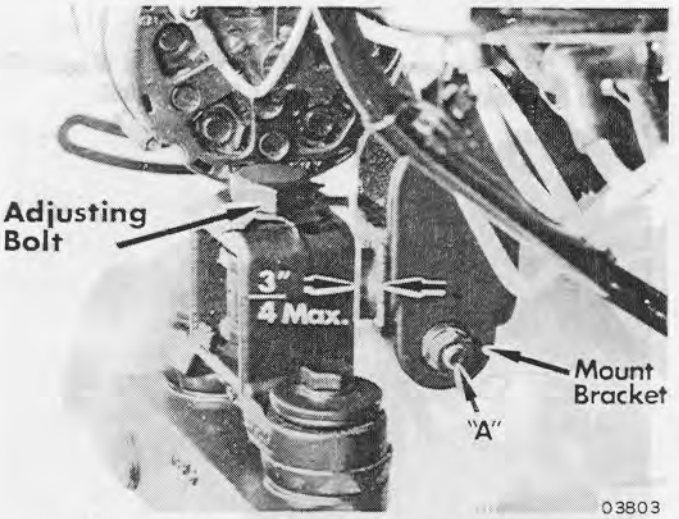

Figure 6. Front Engine Mount Adjustments

13. After correct alignment has been attained, bend tabs of adjusting bolt tab washers down over edges of mounts and re-check all mount fasteners to be sure that they are tight.
14. Remove alignment shaft and plate.

INSTALLING STERN DRIVE UNIT

(For Removal - Reverse the Following Procedure.)

Figure 1. Installation Lubrication Points

1. Lubricate drive shaft housing pilot (Figure 1) and drive shaft splines, "O" ring and oil connectors with New Multipurpose Lubricant (C-92-49588).
   Apply light coat of lubricant to inside surfaces of bell housing bore and position gasket. (Figure 2)
2. Place forward anchor pin in gimbal ring. (Figure 3)

   NOTE: Use hoisting equipment to hold drive during installation.

3. Insert stern drive unit into drive shaft housing bell bore (Figure 3) by guiding splined shaft thru pilot bearings into transmission. If drive shaft splines do not align with splines, place propeller on shaft and rotate propeller shaft slightly until drive unit can be pushed into position.

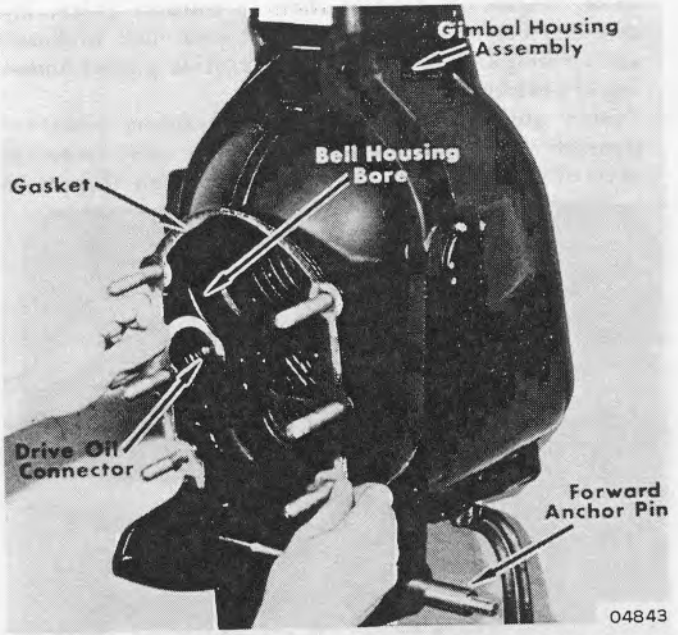

Figure 2. Gasket Position on Bell Housing Studs

4. Fasten drive shaft housing to bell mounting studs with 6 elastic stop nuts and flat washers. Tighten evenly to 80 ft. lbs. (11mkg) torque. (Figure 5)

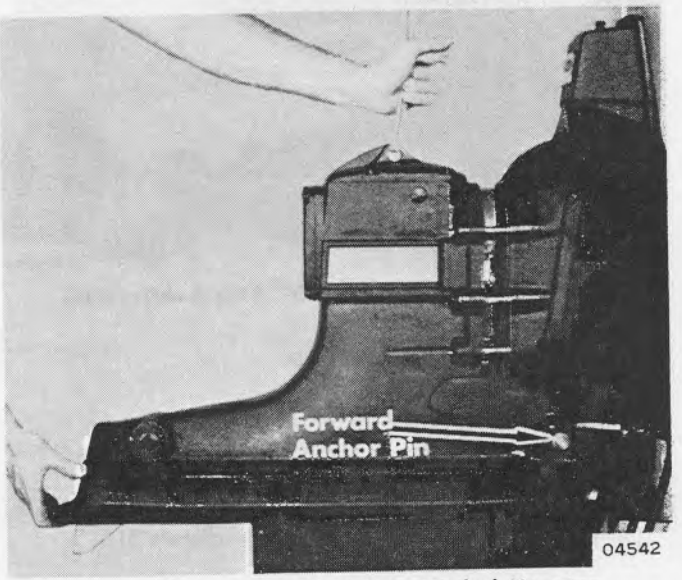

Figure 3. Inserting Unit into Gimbal Housing

TRANSOM PLATE INSTALLATION

1. Lubricate exhaust tube "O" ring in gimbal housing assembly (Figure 1) and inner transom plate exhaust pilot. (Figure 2) Position them in transom holes, inserting electric leads, hydraulic hoses, unit oil hose and steering link rod thru openings. Hold gimbal housing in position.
2. Fasten gimbal housing and inner transom plate to transom with 8 flat washers and stop nuts, torquing them evenly to 25-30 ft. lbs. (3.46-4.15mkg). (Figure 3)

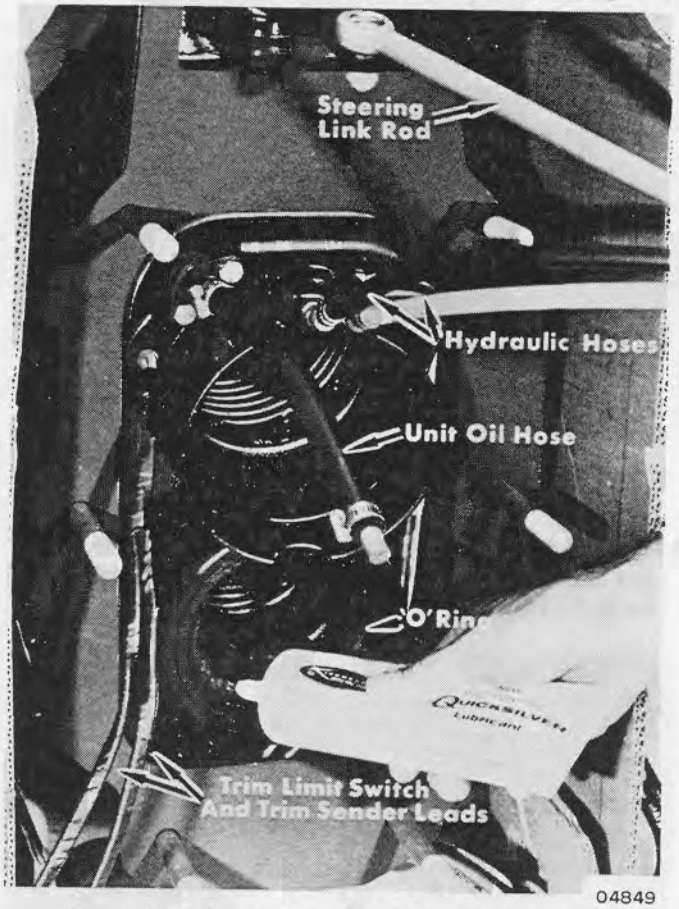

Figure 1. Exhaust Tube "O" Ring Lubrication

INSTALLING HYDRAULIC PUMP

1. Mount pump bracket to transom plate. (Figure 3)
2. Loosen hose fittings at connector, rotate hoses 180° and retighten fittings.
3. Remove cap and plug to install "Up" hose fitting into pump quickly to prevent loss of oil. (Figure 3)

NOTE: Refer to engine installation for connection of hydraulic hoses to reverse lock valve and to hydraulic pump.

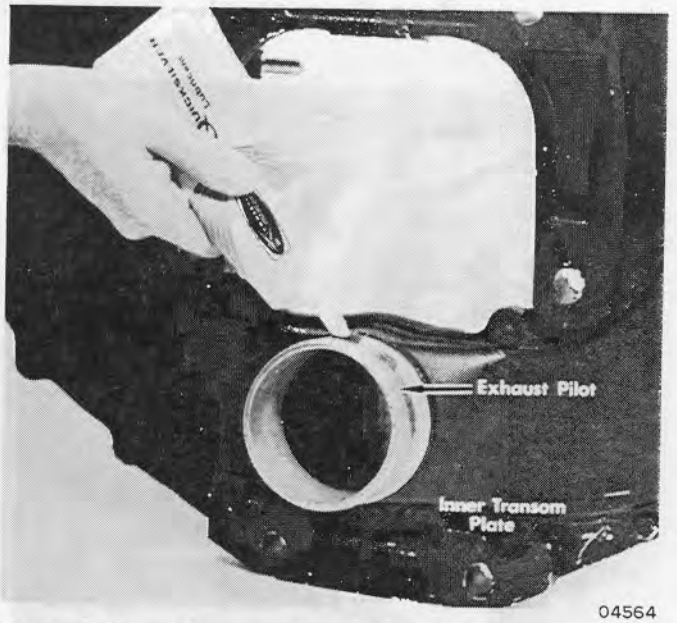

Figure 2. Inner Transom Plate Exhaust Pilot Lubrication

SECURING DRIVE OIL HOSE and FILLING RESERVOIR

1. Slip drive oil hose and clamp over reservoir fitting and tighten clamp securely. (Figure 3)
2. Remove dipstick and fill reservoir with Quicksilver Super-Duty Gear Lubricant (C-92-52655) until oil reaches level line (approx. 2-4 oz.). Do not over-fill.
3. Replace dipstick.

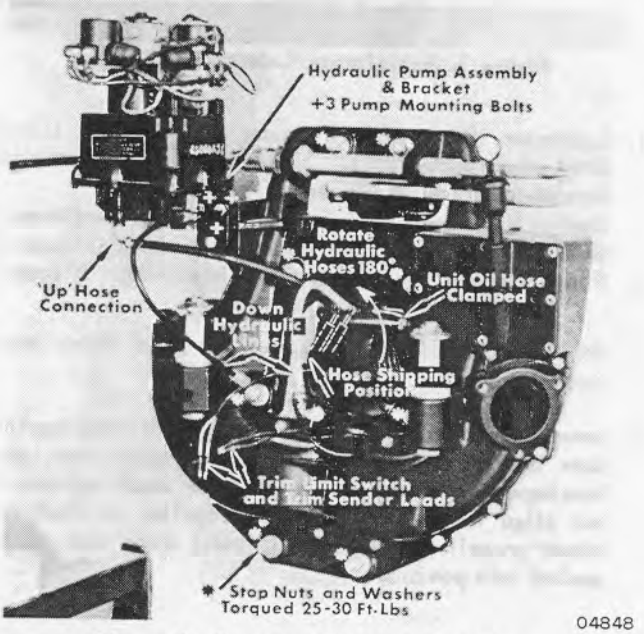

Figure 3. Transom Plate Instaliation

THROTTLE CABLE INSTALLATION

1. Place remote control handle in neutral gear, idle position.
2. Connect cable end guide to throttle lever with screw, bushing, washers and nut. (Figure 1)
3. Grasp cable behind brass barrel and push lightly toward throttle lever. Adjust brass barrel to align with anchor stud and fasten barrel to stud with washers and nut. (Figure 1)

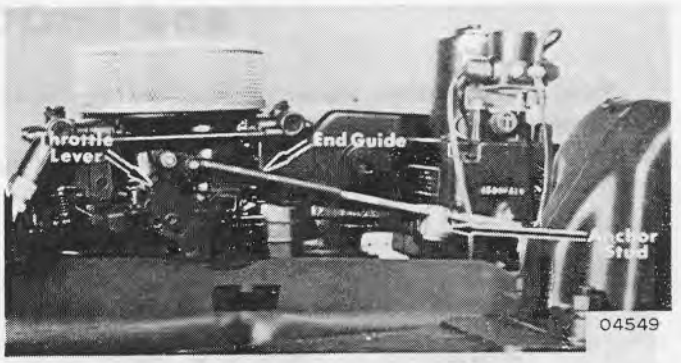

Figure 1. Throttle Cable Installed

SHIFT CABLE INSTALLATION

IMPORTANT: Shift cable must be adjusted to position transmission shift lever as outlined in the following, or transmission failure will occur.

1. Place remote control handle in full forward position.
2. Place transmission in forward gear by moving shift cable lever to the right until detent ball (located behind transmission shift lever) is centered in rear hole in transmission shift lever. (Figure 2)

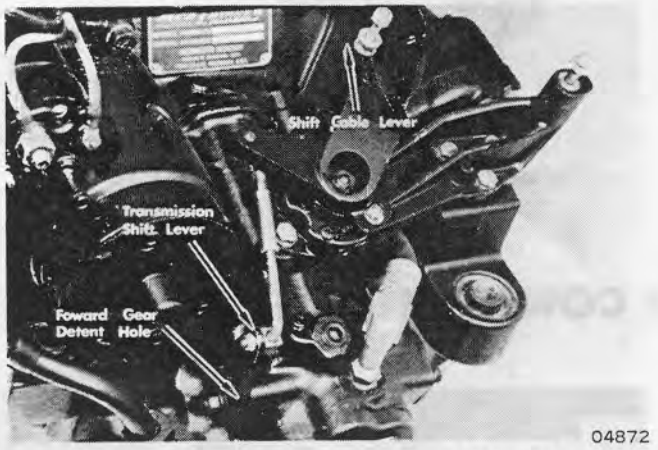

Figure 2. Transmission Shift Lever Position - Forward Gear

3. Place cable end guide on stud which is located in shift cable lever. (Figure 3)
4. Adjust brass barrel on shift cable so that barrel can be placed on anchor stud without disturbing shift cable lever position. (Figure 3)
5. Fasten end guide to shift cable lever stud with flat washer and nut. Tighten nut and then back nut off slightly to allow end guide to pivot freely. (Figure 3)
6. Fasten brass barrel to anchor stud with flat washer and nut. Tighten nut securely. (Figure 3)
7. Place remote control handle in full reverse position.
8. Loosen nut which fastens stud to shift cable lever. Move shift cable lever to the left, while sliding stud down slot in lever, until detent ball is centered in front hole in transmission shift lever. Tighten nut securely. (Figure 4)
9. Check adjustment by moving remote control handle to full forward. Detent ball must be centered in rear hole in transmission shift lever. (Figure 2) Move control handle in full reverse position. Detent ball must be centered in front hole in transmission shift lever. (Figure 4) If transmission shift lever is not positioned correctly and does not permit detent ball to be centered in holes, as described previously, readjust cable.

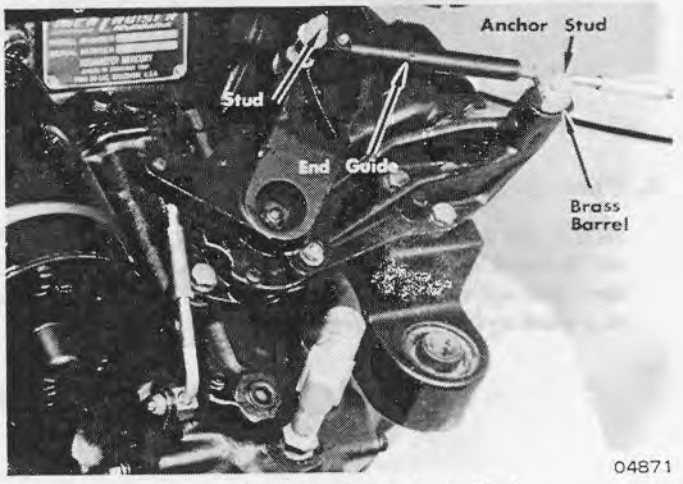

Figure 3. Shift Cable Installed

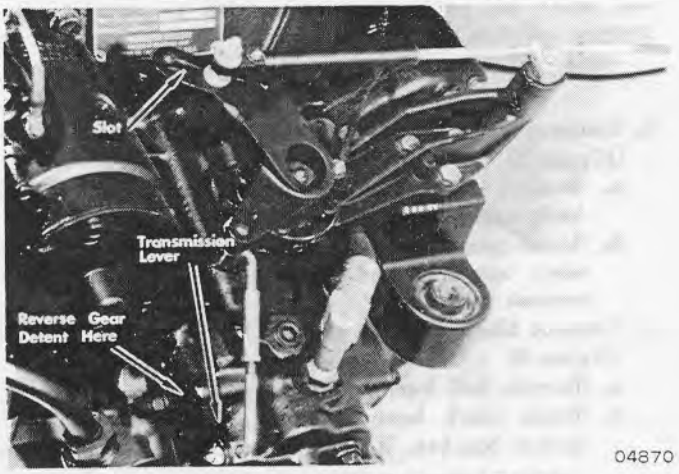

Figure 4. Transmission Shift Lever Position - Reverse Gear

REVERSE LOCK VALVE ADJUSTMENT

Refer to "Accessories" Section 7.

INSTALLING COMBINATION TRIM and SHOCK CYLINDERS

1. Place a flat washer, rubber bushing and one spiral spring on each side of forward anchor pin.
2. Install aft anchor pin, large washer, rubber bushing and one spiral spring on each side of aft anchor pin. (Figure 1)

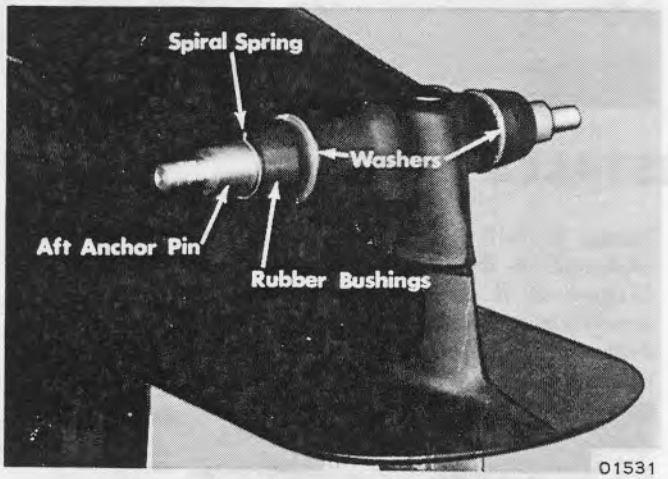

Figure 1. Aft Anchor Pin Installed

3. Place cylinders on anchor pins.

NOTE: Be sure that one small spiral spring is installed between rubber bushings on each side of both forward and aft anchor pins. (Figure 1) They are required to ground cylinders to drive.

4. Place rubber bushings in forward and aft end of each cylinder.
5. Place flat washer on each end of both anchor pins. Install nuts and tighten securely. (Figure 2)

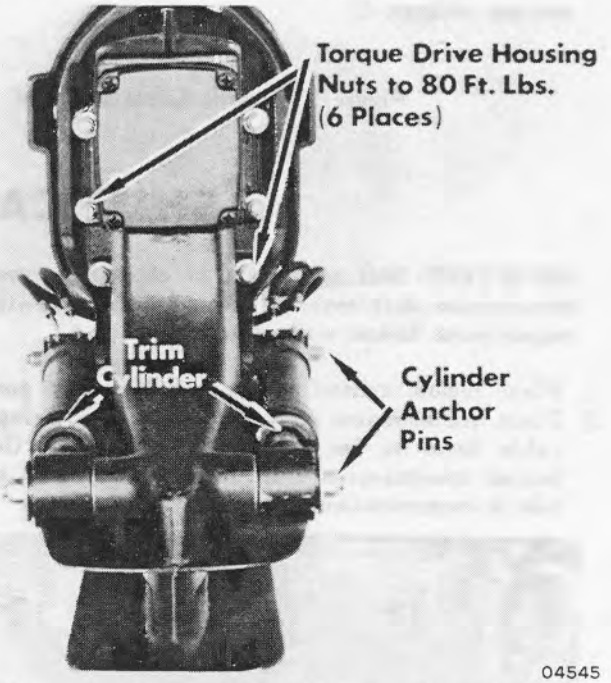

Figure 2. Drive and Trim Cylinders Installed

POWER TRIM HOSE CONNECTIONS

NOTE: Reverse lock valve and hoses are filled with oil. Make all connections as quickly as possible to prevent oil from draining out.

1. Connect gray hose to reverse lock valve as follows: (Figure 3)
   a. Remove shipping plug and plastic seal from reverse lock valve.
   b. Route gray hose under cable anchor bracket. Remove cap from end of hose and connect hose to reverse lock valve.
2. Connect black hose to reverse lock valve as follows: (Figure 3)
   a. Remove ball from reverse lock valve.
   b. Route black hose between shift cable and cable anchor bracket. Remove cap from end of hose and connect hose to reverse lock valve.

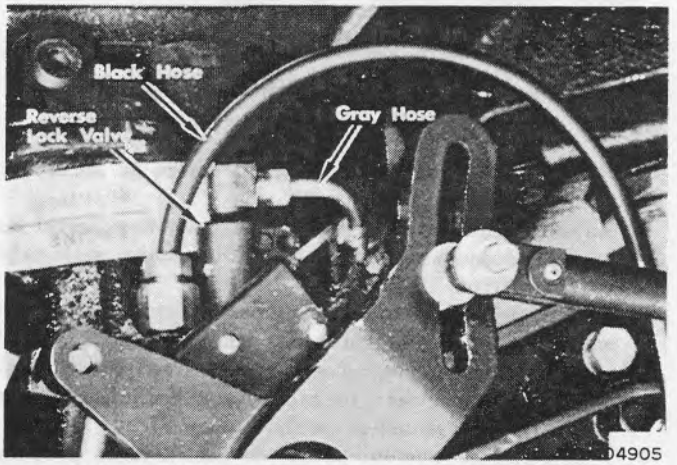

Figure 3. Power Trim Hose Connections - Reverse Lock Valve

RIDE-GUIDE STEERING INSTALLATION

1. Connect steering link rod with pivot bolt in rod, flat washer and curved washer to steering lever. (Figure 4) Align curved washer and tighten nut.
2. Lubricate inside of cable guide tube with New Multi-purpose Lubricant (C-92-49588).

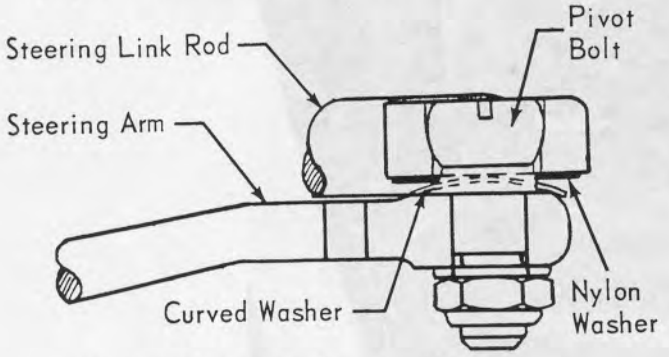

Figure 4. Connecting Steering Link Rod

3. Insert cable end thru tube and thread large hand-type fastening nut on tube securely. (Figure 5 or 6)

   NOTE: To attach steering cable from left, remove Ride-Guide tube and reinstall on transom. (Figure 6)

4. Attach steering link rod to cable end and torque to 12 ft. lbs. (1.7mkg).
5. It is necessary to adjust steering after engine and drive unit are installed. See "Adjusting Ride-Guide Steering", following.

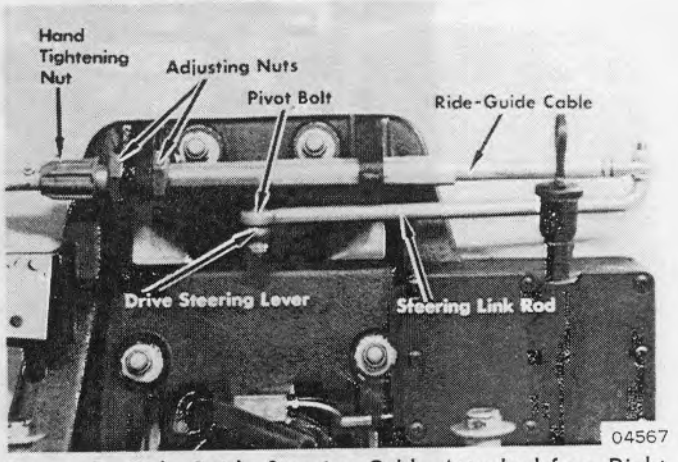

Figure 5. Ride-Guide Steering Cable Attached from Right

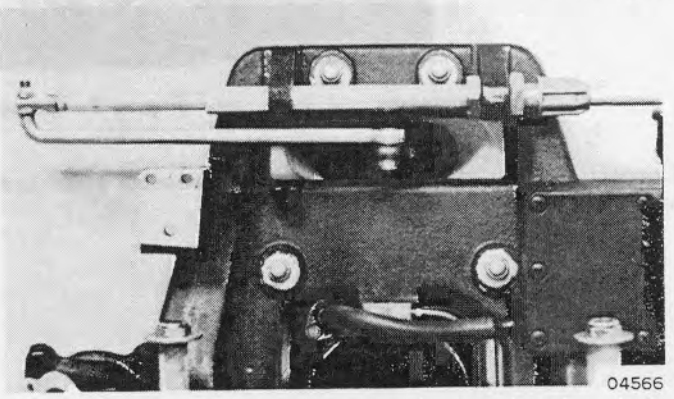

Figure 6. Ride-Guide Steering Cable Attached from Left

ADJUSTING RIDE-GUIDE STEERING

NOTE: Power Steering is recommended for dual installations.

1. Turn steering wheel to full left and right. Drive unit should traverse fully in both directions. If unit turns further in one direction than other, loosen lock nuts and hand-fastening nut and move cable guide tube left or right to allow for full traverse. Tighten adjusting nuts securely. (Figure 5 or 6 under "Ride-Guide Steering Installation", preceding)
2. Turn steering wheel until drive unit is centered. If, at this point, steering wheel is not centered correctly, readjust cable guide tube to center steering wheel, then recheck Step 1.

ELECTRICAL WIRING

NOTE: Refer to "Electrical System" Section 3.

EXHAUST SYSTEM INSTALLATION

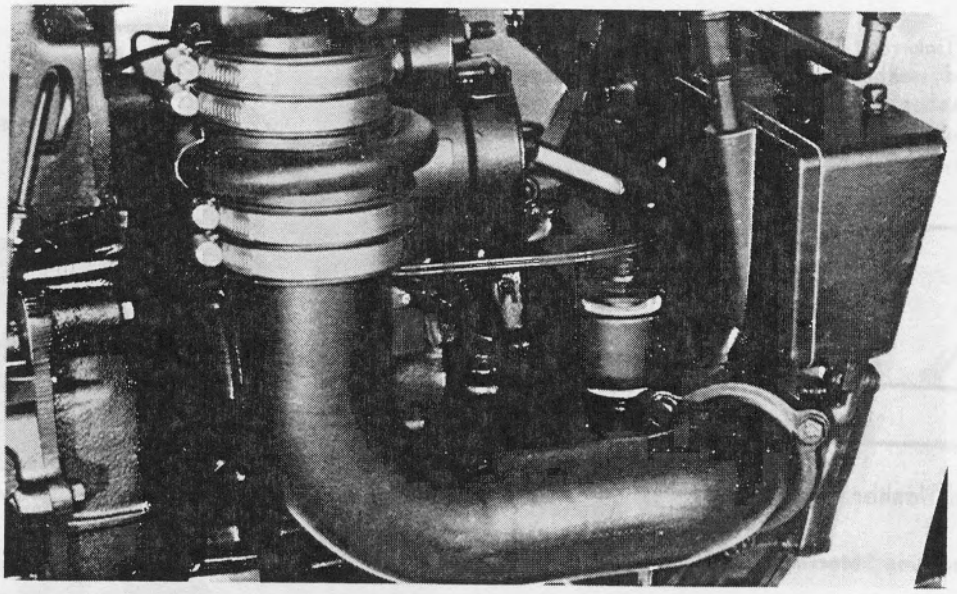

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Figure 7. Exhaust System Installation

Connect exhaust elbows and bellows to transom plate and manifold elbows as shown in Figure 7.

Torque exhaust elbow to transom plate screws to 20-25 ft. lbs. (2.77-3.46mkg).

SECTION 2 - REMOVAL, INSTALLATION and ALIGNMENT

MERCRUISER

PART G - 215-E STERN DRIVE

MERCURY MARINE

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MERCRUISER 215-E ENGINE REMOVAL

NOTE: Stern drive unit must be removed prior to engine removal, if engine cannot be moved forward sufficiently to clear universal joint shaft. Stern drive removal is the reverse of installation.

1. Disconnect battery cables from battery, remove instrument panel harness connector plug from engine harness receptacle and disconnect shift wire connections from terminal block on shift actuator.
2. Disconnect fuel line and throttle cables.
3. Disconnect reverse lock switch wires, trim indicator switch wires and hydraulic pump wires from engine.
4. Remove water inlet tube and exhaust tubes.
5. Support engine with a suitable sling thru the lifting eyes on engine and remove front and rear engine mounting bolts.
6. Remove engine.

ENGINE INSTALLATION and ALIGNMENT

NOTE: Prior to installing engine, transom plates must be installed as outlined in "Stern Drive Installation Manual", DO NOT connect steering link rod to Ride-Guide cable or Power Steering cylinder until AFTER engine alignment has been completed.

Figure 1. Washers Positioned on Transom Plate Engine Support

1. Place one steel washer, one double-wound lockwasher and one neoprene washer on top of each inner transom plate engine support. (Figure 1)

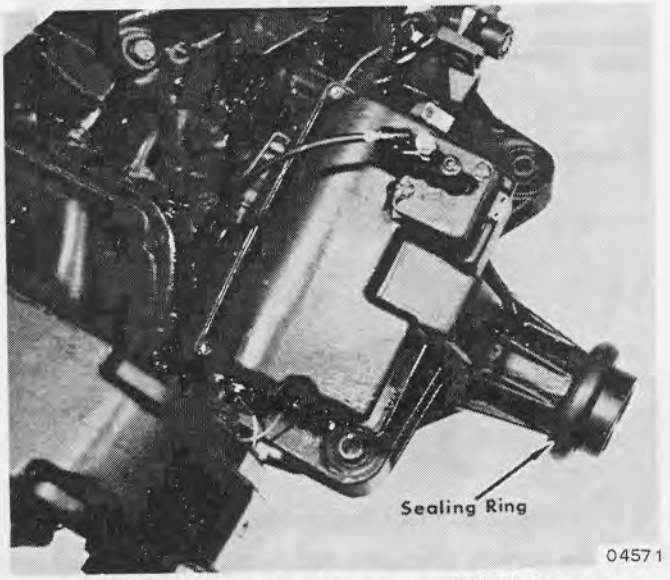


Figure 2. Flywheel Housing and "O" Ring

2. Coat "O" ring seal, which is located as shown in Figure 2, with New Multipurpose Lubricant (C-92-49588).
3. Lift engine with an overhead hoist, using a suitable sling and lifting eyes on engine.
4. Position engine ahead of inner transom plate so that flywheel housing and "O" ring seal (Figure 2) are in line with large opening in inner transom plate.
5. Move engine toward inner transom plate and, at the same time, guide flywheel housing into transom plate opening. Be careful that "O" ring seal does not become damaged. Continue to move engine toward inner plate until holes in rear engine mounts line up with holes in washers and transom plate engine supports.
6. Relieve hoist tension, as required, to allow rear engine mounts to rest on transom plate engine supports and washers.

   IMPORTANT: Do not relieve hoist tension entirely at this time, as rear engine mounts and flywheel housing may be damaged.

7. Insert rear engine mount bolts up thru transom plate, washers and rear engine mounts. Place one neoprene washer and one steel washer on each mount bolt. Thread elastic stop nut on each bolt and torque nut to 100 ft. lbs. (13.8mkg). (Figure 3)
8. Insert end of Alignment Tool Shaft (C-91-57797A1), which has threaded hole, thru opening in bell housing

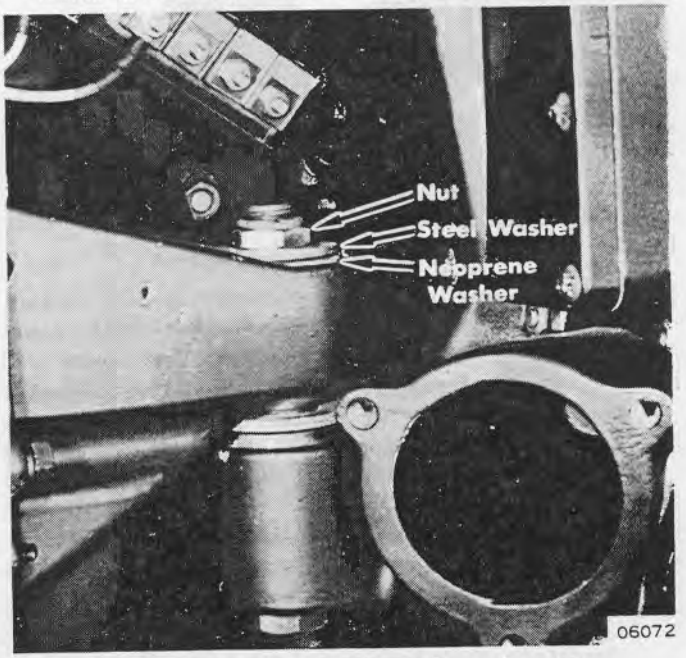


Figure 3. Rear Engine Mount Parts Location

into engine coupling. Insert shaft until it bottoms out in coupling. (Figure 4)

9. Position alignment tool plate on shaft, as shown in Figure 5, and slide plate toward bell housing. Raise or lower front of engine with hoist to allow shoulder on plate to enter bell housing opening.

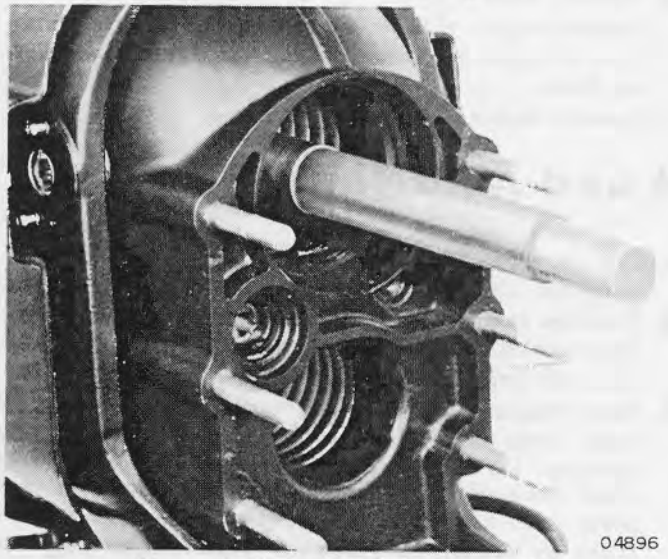


Figure 4. Alignment Shaft Installed

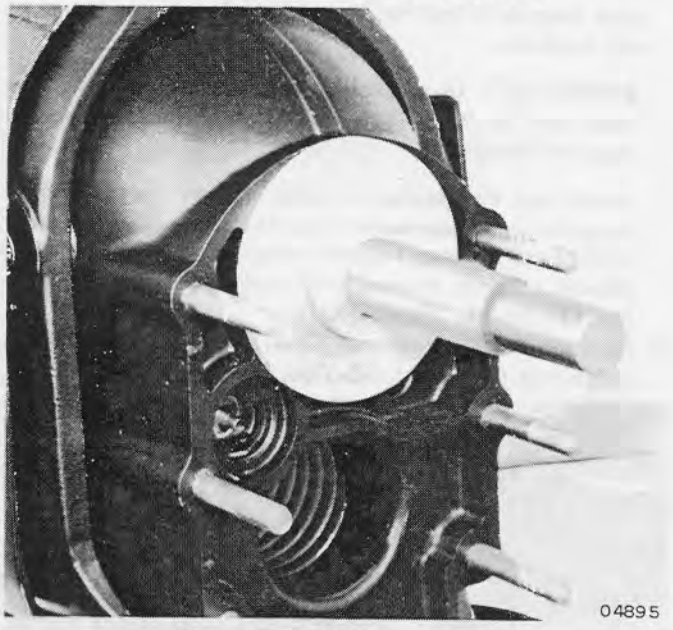


Figure 5. Tool Plate Installed

10. With alignment tool plate positioned in bell housing and engine supported with hoist, front engine mount supports should be constructed so that mounts will rest on top of supports without disturbing alignment tool plate position when hoist tension is relieved.
11. Relieve hoist tension entirely and fasten front mount bases to supports with 3/8" dia. bolts, washers and locknuts.
12. Push alignment shaft and plate toward engine and, while holding plate against bell housing, check for gap between plate and rear surface of bell housing at 12, 3, 6 and 9 o'clock positions. Engine alignment is correct when there is no gap at any point. If gap exists, proceed as follows:

GAP AT 12 O'CLOCK POSITION

Raise front of engine by turning adjusting bolt on both front mounts clockwise. (Figure 6) Turn bolts an equal amount by alternating from one side to the other until gap no longer exists.

GAP AT 6 O'CLOCK POSITION

Lower front of engine by turning adjusting bolt on both front mounts counterclockwise. (Figure 6) Turn both bolts an equal amount by alternating from one side to the other until gap no longer exists.

GAP AT 3 O'CLOCK POSITION

a. Loosen screw and nut ("A" in Figure 6) on both front mounts.
b. Loosen both rear mount bolts 2 turns.
c. Move front of engine to the right (starboard) until gap no longer exists.

IMPORTANT: Mounts must not extend out more than ¾" (19mm) from mount brackets. (Figure 6)

d. Tighten all mount fasteners securely.

GAP AT 9 O'CLOCK POSITION

a. Loosen screw and nut ("A" in Figure 6) on both front mounts.
b. Loosen both rear mount bolts 2 turns.
c. Move front of engine to the left (port) until gap no longer exists.

IMPORTANT: Mounts must not extend out more than ¾"(19mm) from mount brackets. (Figure 6)

d. Tighten all mount fasteners securely.

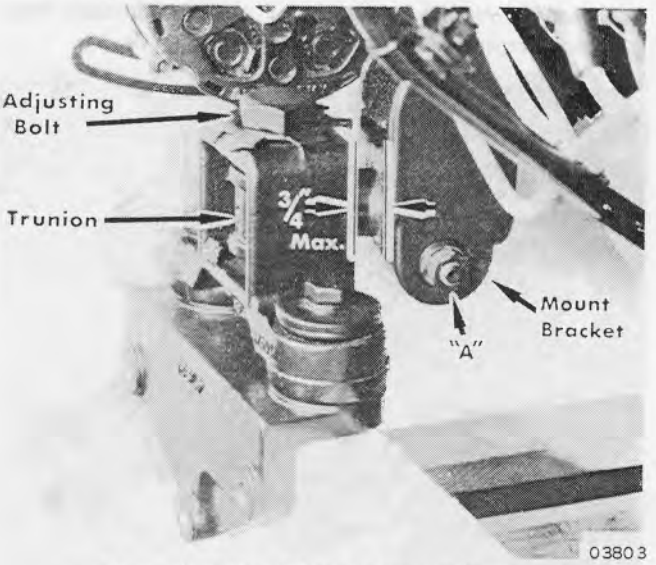


Figure 6. Front Engine Mount Adjustments

13. After correct alignment has been attained, bend tabs of adjusting bolt tab washers down over edges of mounts and re-check all mount fasteners to be sure that they are tight.
14. Remove alignment shaft and plate.

INSTALLING STERN DRIVE UNIT

(For Removal - Reverse the Following Procedure)

IMPORTANT: *Drive units are set up for left hand propeller shaft rotation in forward gear. If right hand propeller shaft rotation is required, complete Step No. 3, following.*

CAUTION: Operating shift without drive unit installed will cause clutch plate misalignment. DO NOT connect electrical shift control harness leads to actuator box unless battery is disconnected or the fuse is removed from the holder in red lead which is located over the engine flywheel housing. Allow these leads to be disconnected until drive unit is installed. If clutch plate has moved out of position, an Engine Alignment Shaft (C-91-57797A1) with Clutch Alignment Tool (C-91-57795) will be necessary to realign the clutch plate, following.

1. Stern drive propeller shaft rotation is set for left hand. If right hand rotation is desired, complete the following:
   a. Remove stop screw from shifter gear at left hand positioning hole. (Figure 1)
   b. Install stop screw with Loctite "A" (C-92-32609-1) in shifter gear thru right hand position hole. (Figure 1)
   c. Rotate shifter gear shaft clockwise with small screwdriver until stop screw butts against stop and is visable at left hand positioning hole. This is forward gear for right hand rotation.
   d. Be sure to use propeller of proper rotation, as indicated on propeller chart.

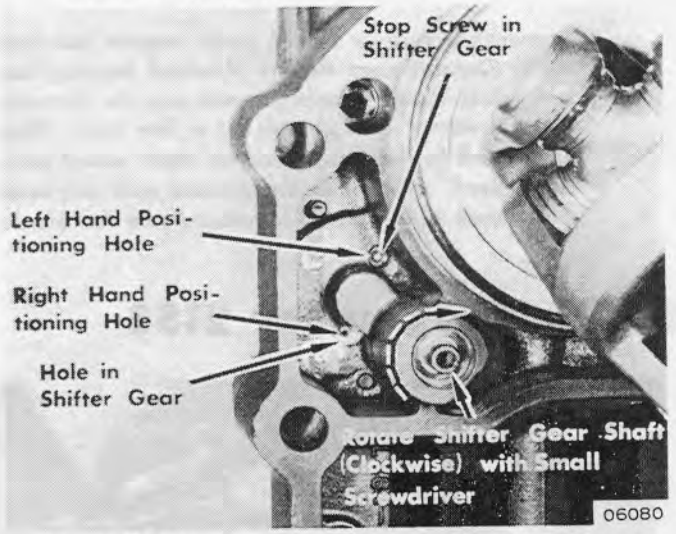


Figure 1. Changing Drive Propeller Shaft Rotation

2. Lubricate land on drive shaft housing pilot (Figure 2), "O" ring and oil and shift connectors with New Multipurpose Lubricant (C-92-49588). Apply a light coat of lubricant to inside surfaces of bell housing bore and position gasket. (Figure 3)

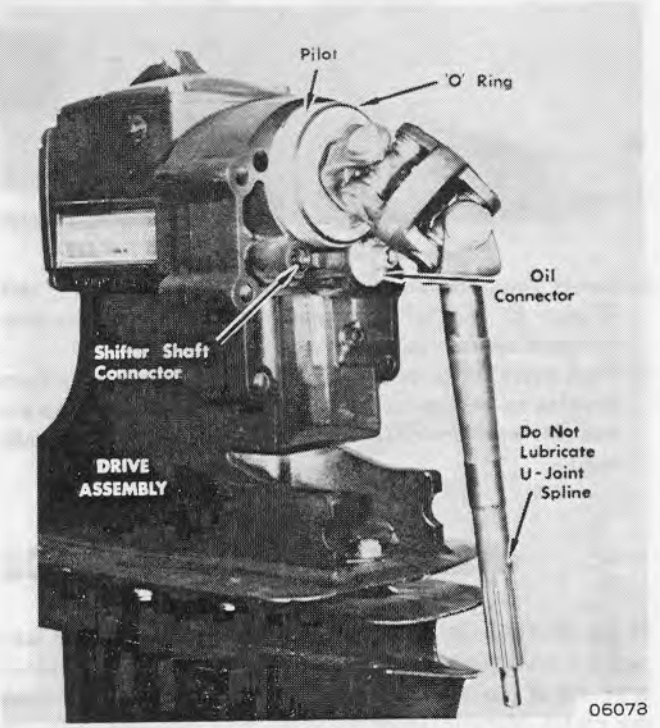


Figure 2. Installation Lubrication Points

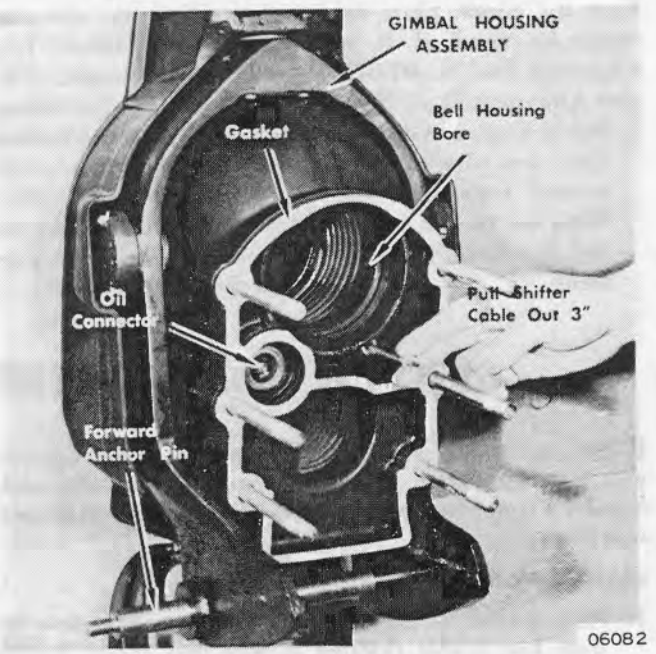


Figure 3. Lubricating Bell Housing Bore

NOTE: Do not lubricate drive shaft splines.

3. Place forward anchor pin in gimbal ring. (Figure 3)

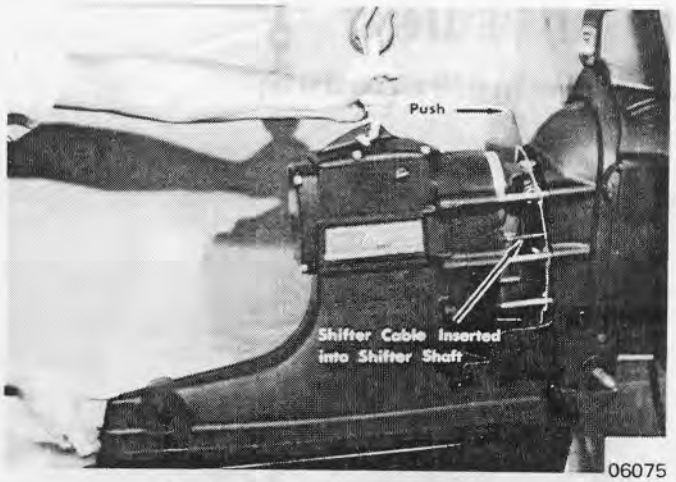


Figure 4. Installing Stern Drive

6. Insert squared end of shifter shaft into connector shaft. (Figure 4) DO NOT turn connector shaft in stern drive to insert shifter cable.
7. Push stern drive completely into bell housing and fasten housing to bell mounting studs with 6 elastic stop nuts and flat washers. Tighten evenly to 80 ft. lbs. (11mkg) torque.

NOTE: If drive shaft splines do not align with clutch disc splines, rotate universal joint shaft slightly until drive can be pushed into bell housing. If stern drive still cannot be pushed into position, complete "Clutch Plate Realignment", following.

8. Install unit shifter shaft, following.
9. Check shift harness connection to actuator box.
10. Reinstall fuse in fuse holder over engine flywheel housing.

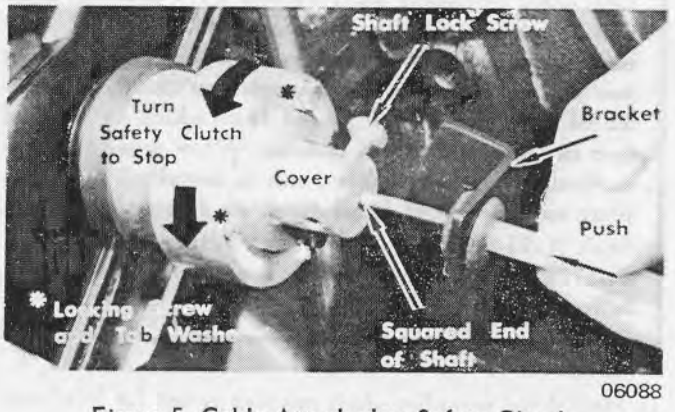


Figure 5. Cable Attached to Safety Clutch

MERCRUISER 215-E CLUTCH PLATE REALIGNMENT

If the MerCruiser 215-E electric shift is activated without the drive unit installed, the engine clutch plate will drop out of position. The drive universal joint shaft holds the clutch plate in position when it is released during the shifting cycle.

When the clutch plate is out of position, the drive unit cannot be installed. In order to reposition, Clutch Plate Alignment Tool (C-91-57795) must be used in end of Engine Alignment Shaft (C-91-57797A1). Realign as follows:

1. Insert Engine Alignment Shaft with Clutch Alignment Tool thru clutch plate splines with the electric shift control connected and placed in neutral position*. When the tool is fully thru clutch plate, shift the control into forward*. This will hold clutch plate in alignment.
2. Remove fuse from holder in red lead (located over engine flywheel housing) to prevent a possible shift cycle without the drive installed.
3. Remove alignment tools and install drive unit.

IMPORTANT: Leave this fuse disconnected when the drive unit is not installed.

* *To manually release clutch plate, remove fuse from holder (located over engine flywheel housing) and turn safety clutch toward forward gear (in direction of decal arrow) until it reaches a firm stop. Then, turn clutch in opposite direction until clutch plate is released. After positioning plate with alignment tool, return safety clutch to forward gear (as above).*

CLUTCH ADJUSTMENT CHECK - MerCruiser 215E

If stern drive unit does not shift smoothly when engine is operating, the clutch requires adjustment. The 215E model requires a clutch adjustment check after the first 20 hours of operation.

CLUTCH ADJUSTMENT CHECK

1. Place electric MerControl in forward gear and remove fuse from fuse holder (located in wire over engine flywheel housing).
2. Loosen locknut on clutch lever and turn adjusting screw out ½-turn, then tighten locknut and reinstall fuse. (Figure 6)

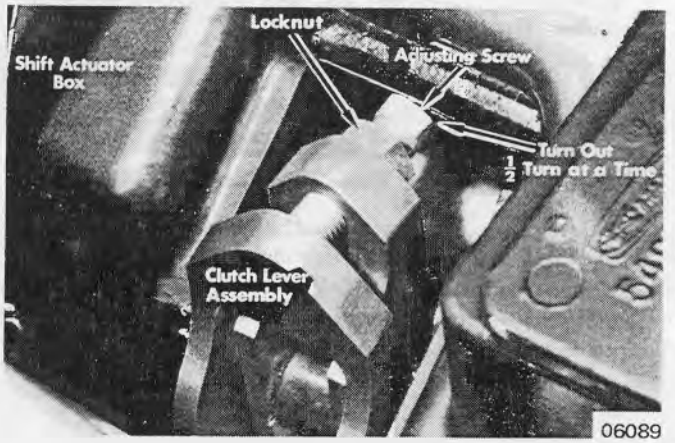


Figure 6. Clutch Lever Assembly

3. Start engine, shift into reverse gear, then into forward gear. Adjust clutch again, if necessary, to obtain smooth shifting.

IMPORTANT: DO NOT turn adjusting screw out more than ½-turn at a time or more than required to smooth-out shifting. Over-adjustment will cause clutch drag in neutral.

EMERGENCY MANUAL SHIFT OPERATION

MerCruiser 215E

IMPORTANT: If shifting electric MerControl becomes difficult or impossible, the stern drive can be shifted manually into forward gear by accomplishing the following:

1. Remove fuse from fuse holder (located in wire over engine flywheel housing).
2. Turn safety clutch in direction of decal arrow until it reaches a firm stop. Drive then will be in forward gear.
3. Remove jumper wedge from holder on rear of port rocker cover.
4. Jam wedge between 2 yellow color-coded terminals on port side of shift actuator box. This will allow engine to be started while "in gear". (Figure 7)

WARNING: When restarting engine, place throttle in idle. Remember that stern drive is in gear! Cautiously stop and start engine to control forward motion of boat, as drive cannot be shifted into reverse gear.

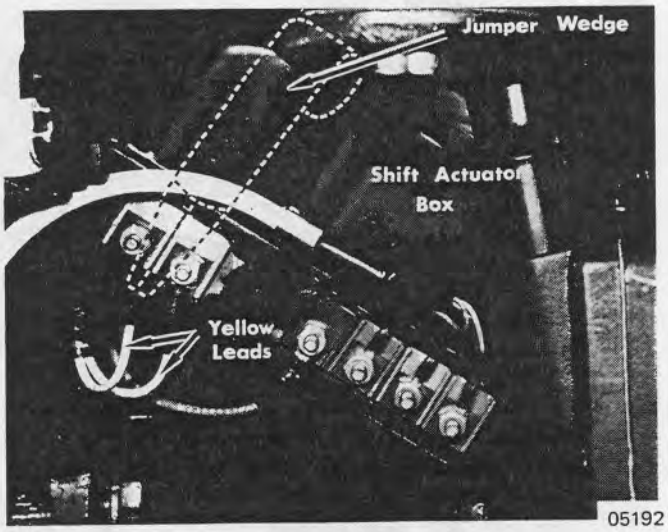


Figure 7. Jumper Clip Installation

INSTALLING UNIT SHIFTER SHAFT

CAUTION: Electric shift control harness should not be connected without drive unit installed.

1. Routing
   a. Route LONG flexible shaft and cable housing under engine mount without sharp bends thru brackets (Figure 8) to actuator box safety clutch.
   b. Route SHORT cable housing over engine mount (Figure 9) thru bracket to safety clutch.
2. Insert flexible shaft fully into safety clutch cover (Figure 5) and tighten lock screw to 55 in. lbs. (9.76kg/cm).

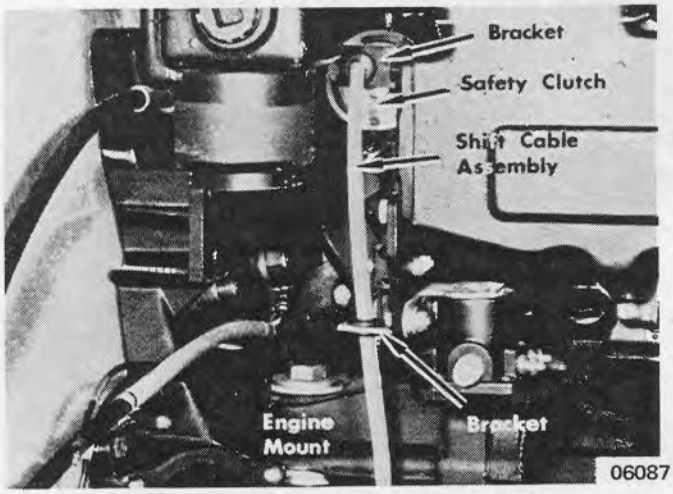


Figure 8. Routing Long Flexible Shaft

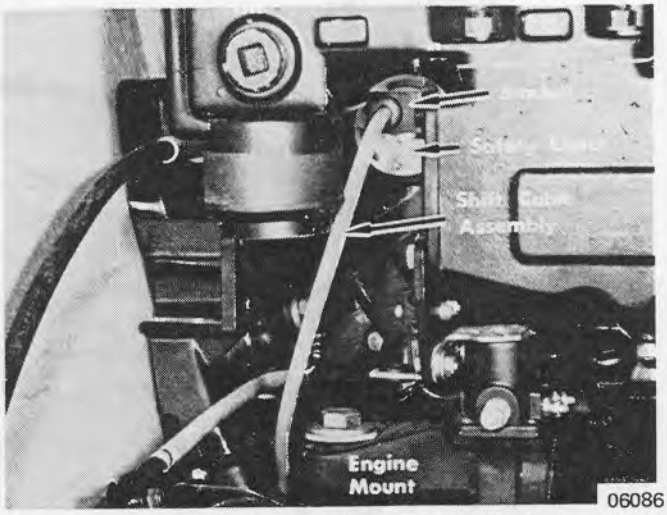


Figure 9. Routing Short Flexible Shaft

IMPORTANT: DO NOT turn flexible shaft to align with safety clutch cover. If squared shaft end is not aligned, rotate safety clutch to forward gear stop (in direction of decal arrow). Loosen 3 screws in safety clutch cover (Figure 5) and rotate in slots until shaft can be installed. Tighten 3 screws to 24 in. lbs. (4.26 kg/cm) and bend tabs to lock screws.

3. Attach electrical leads from shift control.
4. Cycle shift control 2 times to automatically set shift synchronization.

TRANSOM PLATE INSTALLATION

1. Lubricate exhaust tube "O" ring in gimbal housing assembly (Figure 1) and inner transom plate exhaust pilot. (Figure 2) Position them in transom holes, inserting switch leads, hydraulic hoses, unit oil hose, shifter control cable and steering link rod thru openings. Hold gimbal housing in position.

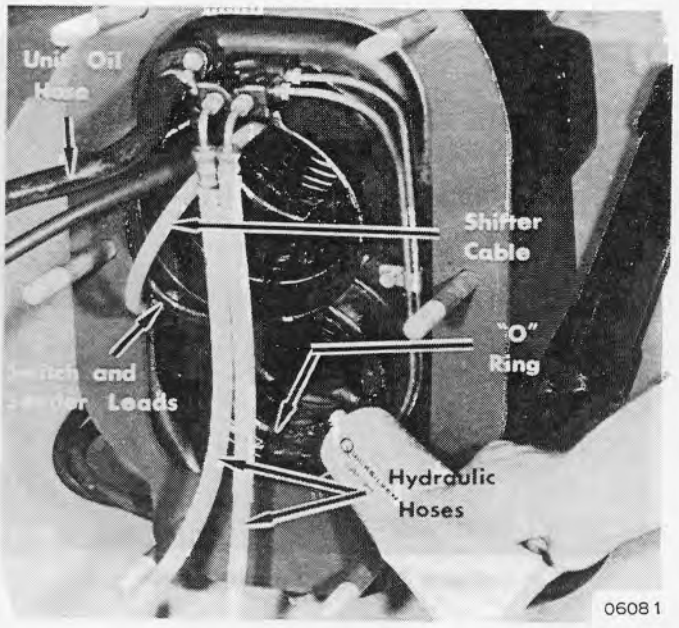


Figure 1. Exhaust Tube "O" Ring Lubrication

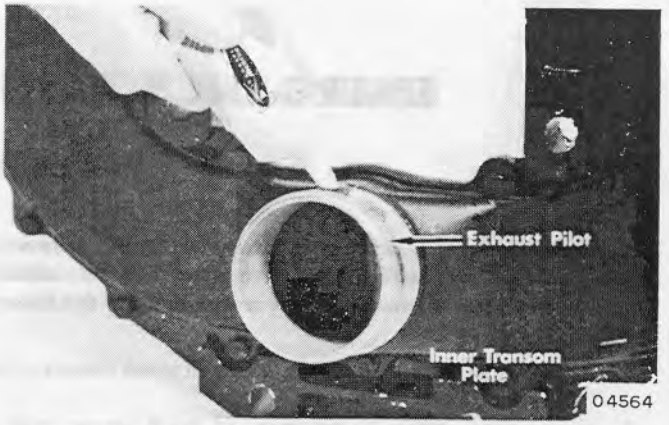


Figure 2. Inner Transom Plate Exhaust Pilot Lubrication

2. Fasten gimbal housing and inner transom plate to transom with 8 flat washers and stop nuts, torquing them evenly to 25-30 ft. lbs. (3.46-4.15mkg). (Figure 3)

INSTALLING HYDRAULIC PUMP

1. Mount pump to floor of boat with floor mounting bracket and 6 lag screws provided (Figures 3 and 4) within reach of pump hydraulic lines (Figure 3) or mount pump to transom of boat with transom mounting brackets and 2 carriage bolts provided.
   NOTE: Hydraulic pump may be mounted on port side of transom plate.

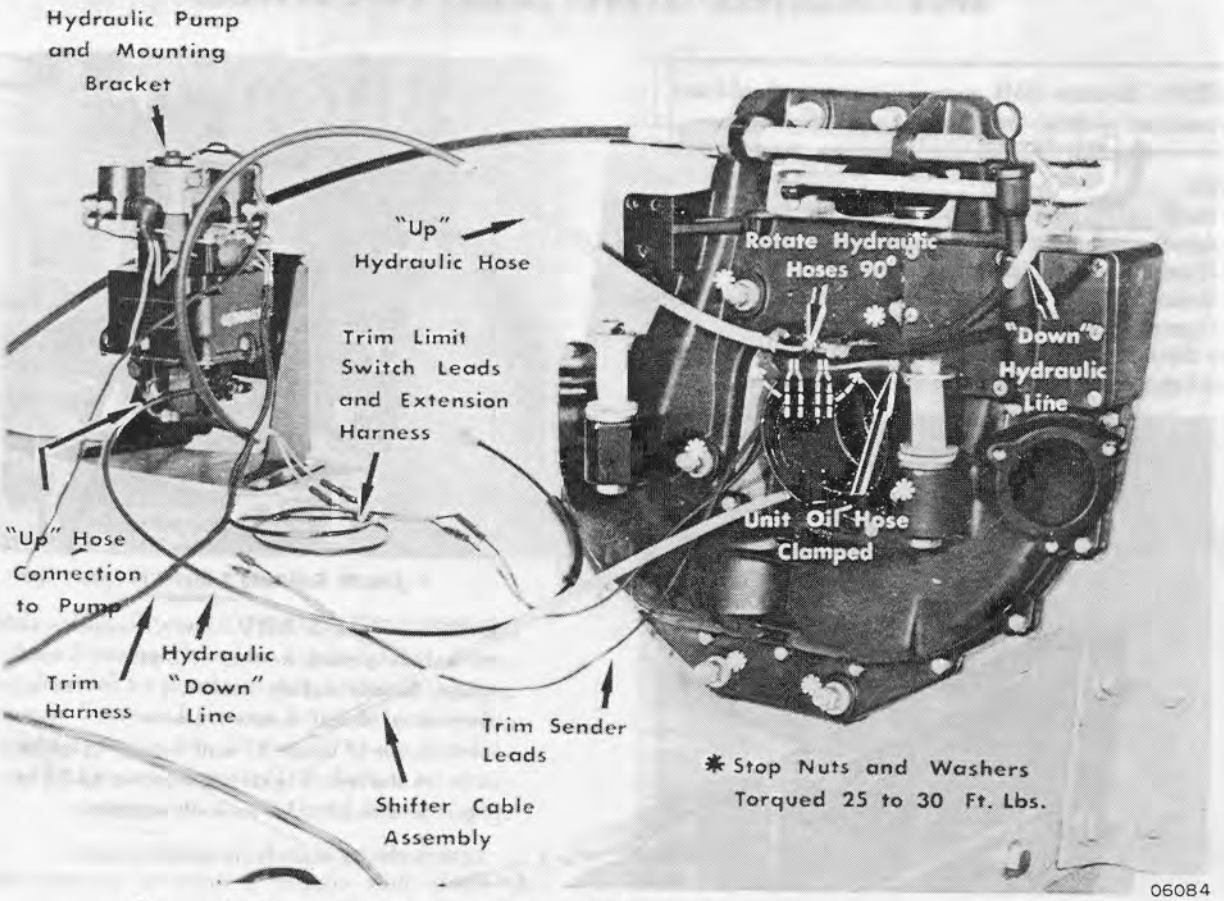


Figure 3. Transom Plate Installation (Hydraulic Pump Mounted on Starboard Side)

NOTE: The 2 drilled holes for the transom mounting pump brackets must be perpendicular to the transom.

2. Loosen 90° fittings at connector, turn hoses away from each other (Figure 3) and retighten fittings.
3. Install (black) "up" hose fitting into pump. (Figure 3)

SECURING DRIVE OIL HOSE and FILLING RESERVOIR

1. Slip drive oil hose and clamp over reservoir fitting and tighten clamp securely. (Figure 3)
2. Remove dipstick and fill reservoir with Quicksilver Super-Duty Gear Lubricant (C-92-52655) until oil reaches level line (approx. 2-4 oz.). Do not over-fill.
3. Replace dipstick.

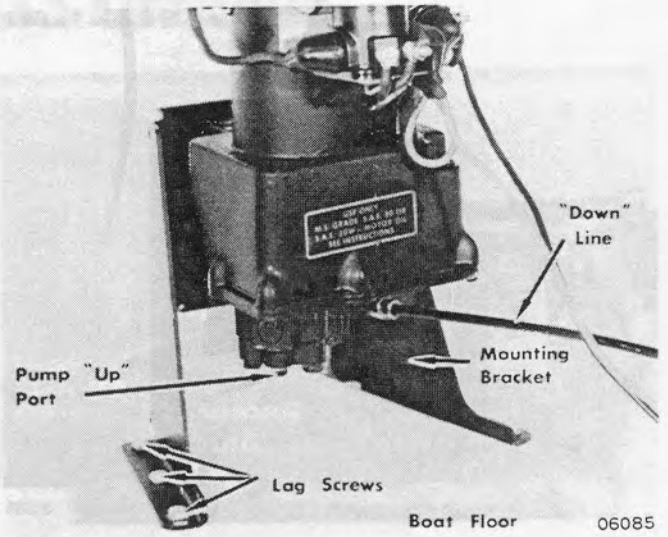


Figure 4. Locating and Mounting Hydraulic Pump Bracket

EXHAUST SYSTEM INSTALLATION

1. Connect exhaust elbows and bellows to transom plate and manifold elbows as shown in Figure 5.
2. Connect ground wire to right side exhaust elbow attaching screw. (Figure 5)
3. Torque exhaust elbow to transom plate screws to 20-25 ft. lbs. (2.77-3.46mkg).

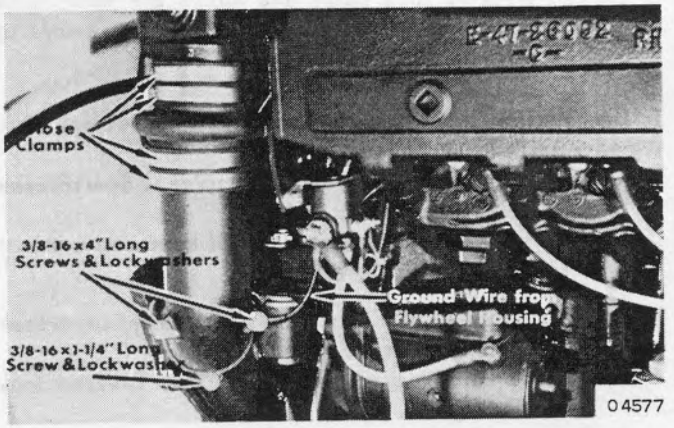
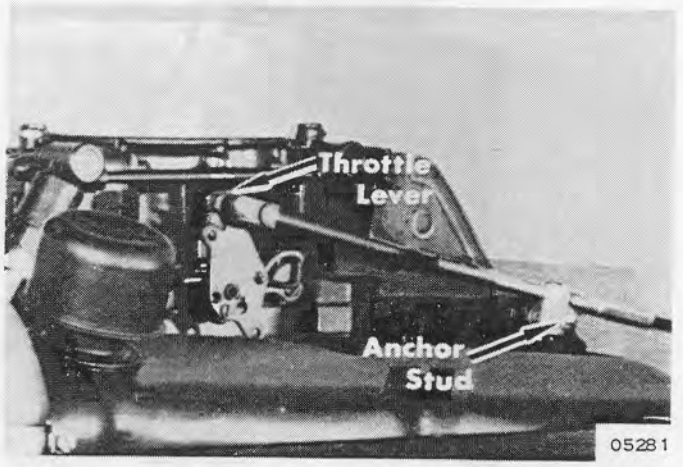


Figure 5. Exhaust System Installation (Right Side Shown)

THROTTLE CABLE INSTALLATION



Before proceeding with the following instructions, install remote control throttle cable as outlined in instructions which accompany control.

1. Place remote control handle in neutral gear, idle position.
2. Connect cable end guide to throttle lever with screw, bushing, washers and nut. (Figure 1)
3. Grasp cable behind brass barrel and push lightly toward throttle lever. Adjust brass barrel to align with anchor stud and fasten barrel to stud with washers and nut. (Figure 1)

Figure 1. Throttle Cable Installed

POWER TRIM HOSE CONNECTIONS

NOTE: Reverse lock valve and hoses are filled with oil. Make all connections as quickly as possible to prevent oil from draining out.

1. Connect gray hose (from transom plate) to reverse lock valve as follows: (Figure 2)
   a. Remove shipping plug and plastic seal from reverse lock valve fitting.
   b. Remove shipping cap from end of hose and connect hose to reverse lock valve.
2. Connect black plastic hose (from trim pump) to reverse lock valve as follows: (Figure 2)
   a. Remove shipping plug and ball from reverse lock valve fitting.
   b. Remove shipping cap from hose and connect hose to reverse lock valve.

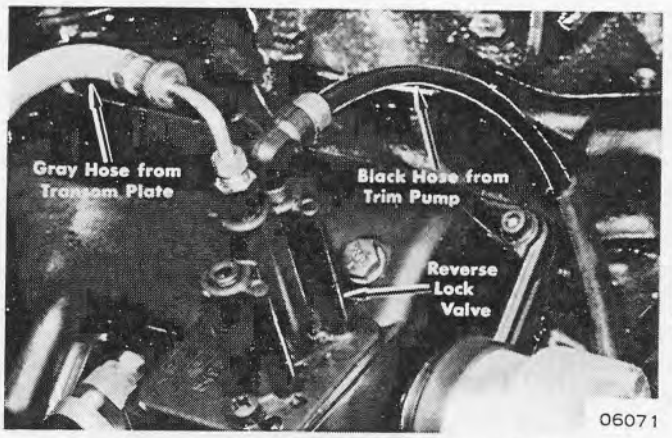


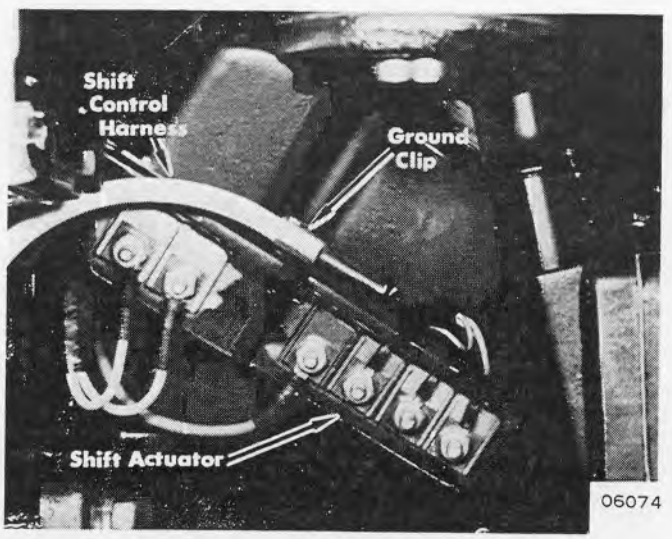
Figure 2. Power Trim Hose Connections - Reverse Lock Valve

SHIFT CONTROL WIRING CONNECTIONS

IMPORTANT: Stern drive unit must be installed as outlined in Stern Drive Unit Installation Manual, and battery cables must be disconnected from battery prior to connecting shift control wiring to shift actuator. This is extremely important, as operation of shift actuator without drive unit installed will cause clutch plate misalignment.

1. Connect ring terminals (located on shift control harness) to terminals on shift actuator, matching lead and terminal colors. (Figure 3)
2. Remove center shift actuator cover attaching screw. Insert screw thru shift control harness ground clip and reinstall screw. (Figure 3)

Figure 3. Shift Control Wiring Connections



INSTALLING COMBINATION TRIM and SHOCK CYLINDERS

1. Place a flat washer, rubber bushing and one spiral spring on each side of forward anchor pin.
2. Install aft anchor pin, large washer, rubber bushing and one spiral spring on each side of aft anchor pin. (Figure 4)

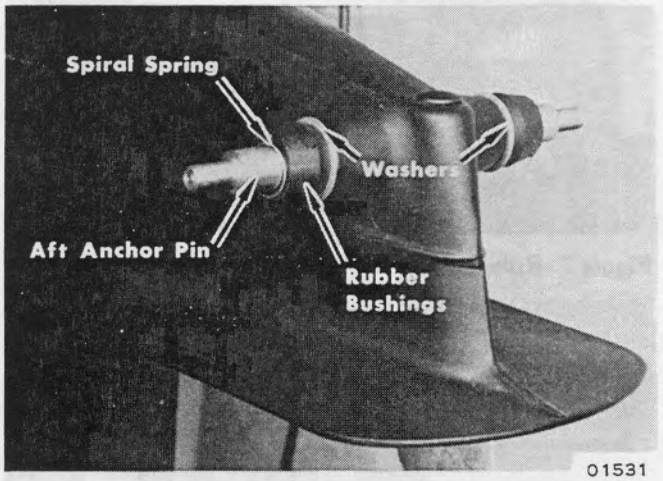


Figure 4. Aft Anchor Pin Installed

3. Place cylinders on anchor pins.

NOTE: Be sure that one small spiral spring is installed between rubber bushings on each side of both forward and aft anchor pins. (Figure 4) They are required to ground cylinders to drive.

4. Place rubber bushings in forward and aft end of each cylinder.
5. Place flat washer on each end of both anchor pins. Install nuts and tighten securely. (Figure 5)

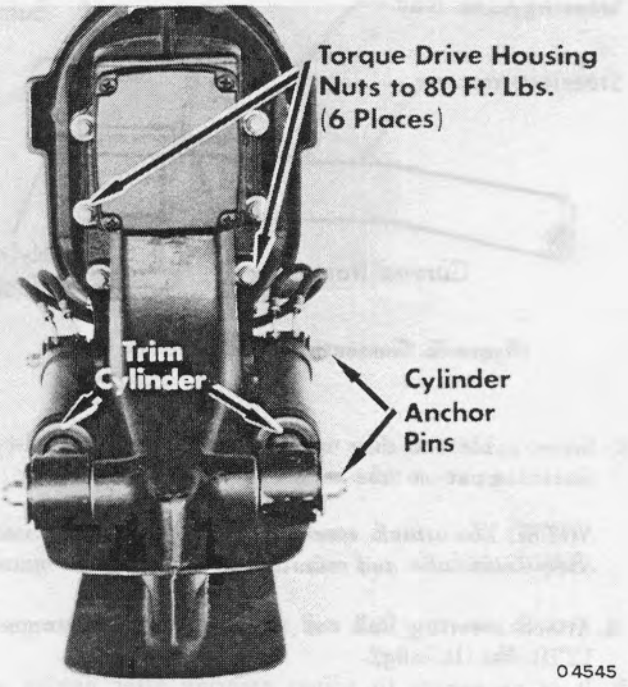


Figure 5. Drive and Trim Cylinders Installed

RIDE-GUIDE STEERING INSTALLATION

1. Connect steering link rod with pivot bolt in rod, flat washer and curved washer to steering lever. (Figure 6) Align curved washer and tighten nut.
2. Lubricate inside of cable guide tube with New Multi-purpose Lubricant (C-92-49588).

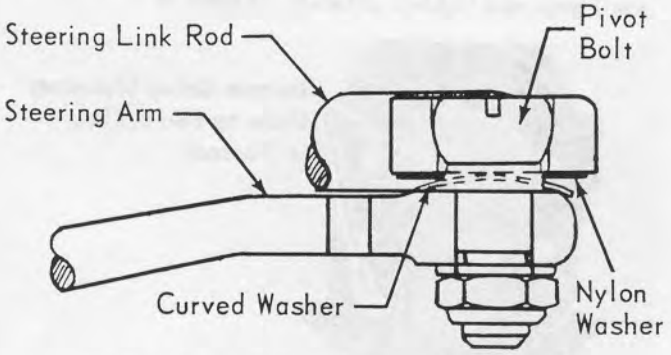


Figure 6. Connecting Steering Link Rod

3. Insert cable end thru tube and thread large hand-type fastening nut on tube securely. (Figure 7 or 8)

   NOTE: To attach steering cable from left, remove Ride-Guide tube and reinstall on transom. (Figure 8)

4. Attach steering link rod to cable end and torque to 12 ft. lbs. (1.7mkg).
5. It is necessary to adjust steering after engine and drive unit are installed. See "Adjusting Ride-Guide Steering", following.

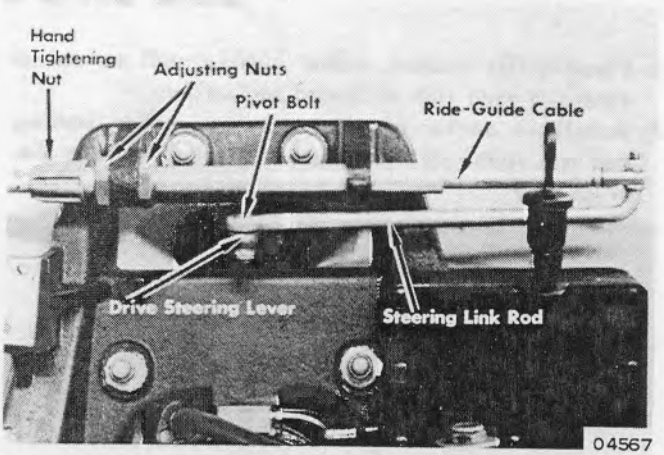


Figure 7. Ride-Guide Steering Cable Attached from Right

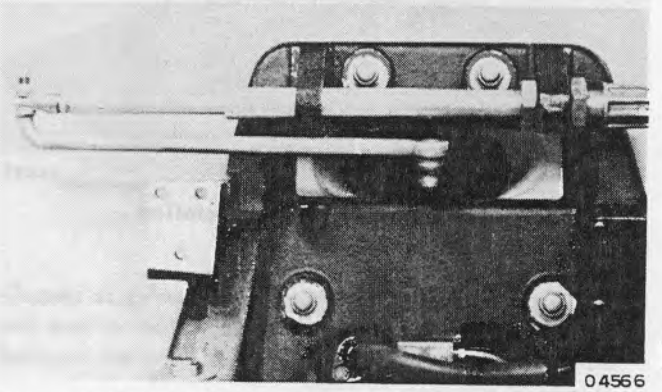


Figure 8. Ride-Guide Steering Cable Attached from Left

ADJUSTING RIDE-GUIDE STEERING

NOTE: Power Steering is recommended for installations.

1. Turn steering wheel to full left and right. Drive unit should traverse fully in both directions. If unit turns further in one direction than other, loosen lock nuts and hand-fastening nut and move cable guide tube left or right to allow for full traverse. Tighten adjusting nuts securely. (Figure 7 or 8 under "Ride-Guide Steering Installation", preceding)
2. Turn steering wheel until drive unit is centered. If, at this point, steering wheel is not centered correctly, readjust cable guide tube to center steering wheel, then recheck Step 1.

ADJUSTING POWER STEERING

Refer to Section 7, Part B, "Power Steering".

ELECTRICAL WIRING

NOTE: Refer to "Electrical System", Section 3.

SECTION 2 - REMOVAL, INSTALLATION and ALIGNMENT

MERCRUISER

PART H - "888" STERN DRIVE

MERCURY MARINE

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MERCRUISER "888" ENGINE

REMOVAL

NOTE: Stern drive must be removed prior to engine removal.

1. Disconnect battery cables from battery and remove instrument panel harness connector plug from engine harness receptacle.
2. Disconnect fuel line and throttle and shift control cables.
3. Disconnect reverse lock switch wires, trim indicator wires and hydraulic pump wires from engine.
4. Remove water inlet tube and exhaust tubes.
5. Support engine with a suitable sling thru the lifting eyes on engine and remove front and rear engine mounting bolts.
6. Remove engine.

INSTALLATION and ALIGNMENT

NOTE: It is necessary that the transom plates and exhaust elbows are installed before proceeding with "Engine Installation and Alignment".

1. Place one double-wound lockwasher and one fiber washer on top of each inner transom plate engine support. (Fig. 1)

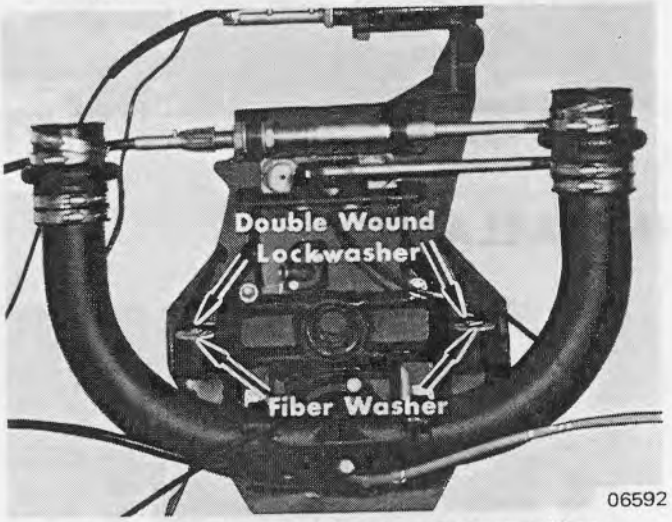

Figure 1. Washers Positioned on Transom Plate Engine Supports

2. Remove plastic shipping plug from engine coupling spline.
3. Lift engine with an overhead hoist, using a suitable sling and lifting eyes on engine. Engine must be suspended so that rear end is slightly lower than front, and front mounts are level.

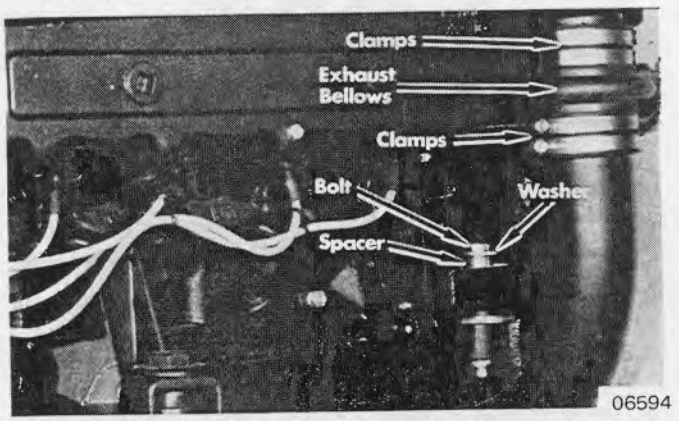

Figure 2. Rear Engine Mount Parts Location

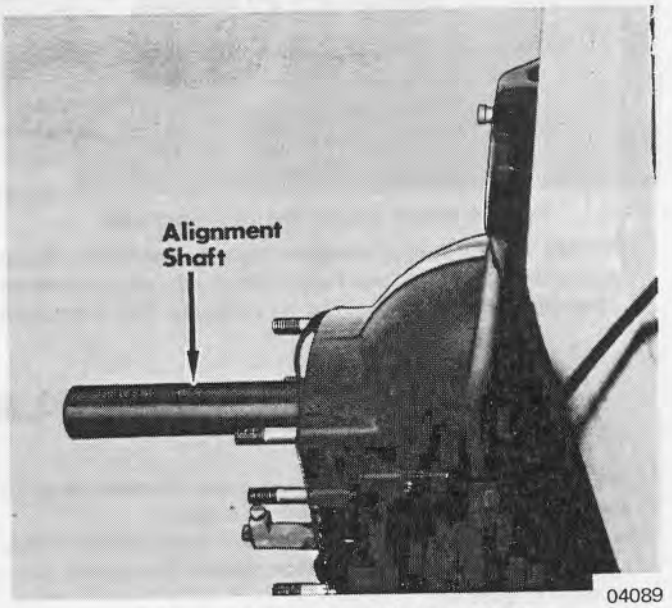

Figure 3. Alignment Shaft Installed

4. Lower engine into position over transom plate and, while lowering, connect exhaust bellows to exhaust elbows. Allow rear engine mounts to rest on transom plate engine supports. Do not relieve hoist tension.
5. Place one steel washer and one spacer on each rear mount bolt and insert bolts down thru engine mounts, washers and mounting brackets. Thread elastic stop nuts on bolts and tighten to 35 to 40 ft. lbs. (4.83 to 5.52 mkg). (Figure 2)
6. Tighten exhaust bellows clamps securely. (Figure 2)
7. Insert end of Alignment Tool (C-91-57797A1) shaft (end without threaded hole) thru gimbal bearing. (Figure 3) Move gimbal bearing with shaft to align shaft with coupling spline and raise or lower front of engine with hoist to allow shaft to enter spline freely. Insert shaft into coupling. After preliminary alignment has been attained, remove alignment shaft and proceed as follows.

NOTE: If front mount bases contact stringers when lowering front of engine, turn mount adjusting bolts (Figure 4) counterclockwise to raise bases up, away from stringers. Preliminary alignment must be made with front of engine supported evenly with hoist and mount bases not contacting stringers.

8. Adjust mount bases to match stringers by loosening screw and nut ("A" in Figure 4) and sliding mounts in-or-out as required.

   IMPORTANT: Mounts must not extend out more than ¾" (19mm) from mount brackets. (Figure 4)

9. Turn adjusting bolt on both front mounts clockwise to lower mounts (Figure 4) until mount bases contact top of stringers. At this point, stop turning bolts and place a reference mark on each bolt head. Turn each bolt clockwise one full turn.

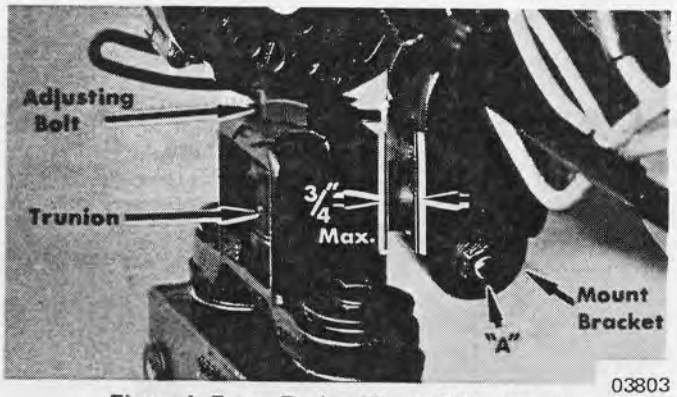

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Figure 4. Front Engine Mount Adjustments

NOTE: Top surface of stringers must be located so that a minimum of ¼" (6.35mm) up-or-down adjustment remains when mount bases are resting on stringers. This is required to perform final engine alignment and re-alignment after boat has been in service.

10. Relieve hoist tension and fasten front mount bases securely to stringers.
11. Recheck alignment shaft fit. Shaft must enter engine coupling freely. If not, turn both front mount adjusting bolts an equal amount by alternating from one side to the other until shaft enters coupling spline freely.
12. Bend tabs of adjusting bolt tab washers down over edges of mounts and recheck all mount fasteners to be sure that they are tight.
13. Place hose clamp on water inlet hose and connect hose to water inlet tube. Tighten hose clamp securely. (Figure 5)

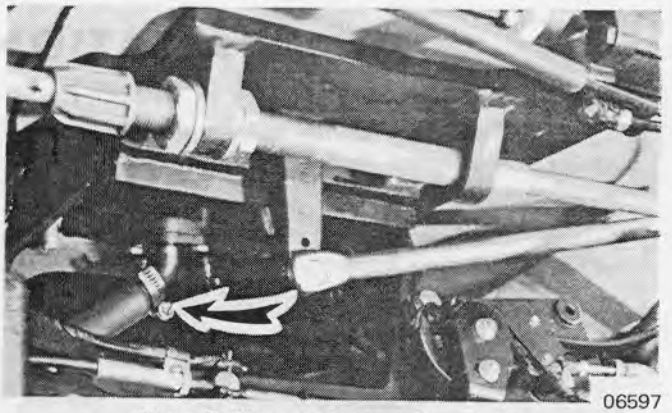
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Figure 5. Water Inlet Hose Connection

TRANSOM PLATE INSTALLATION

1. Set gimbal housing assembly and inner transom plate in position over openings in transom as follows:
   a. Insert shift cable, switch lead and hydraulic hose thru opening in transom and place gimbal housing in position. (Figure 5)

CAUTION: If gimbal housing is held in position by the switch leads while fastening inner transom plate, switch lead or switch could be damaged.

   b. While holding gimbal housing in this position, insert shift cable and hydraulic hose thru large opening and insert switch leads thru small hole in inner transom plate, then set plate in position. (Figure 6)
2. Fasten gimbal housing assembly and inner transom plate to transom as follows:
   a. Thread 2 short cap screws with lockwashers thru top 2 holes of inner transom plate into gimbal housing. (Figure 6) See "CAUTION" under "e", following.
   b. Insert 2 special anode head bolts with rubber seals under heads thru bottom 2 holes of gimbal housing, transom and inner transom plate.
   c. Place flat washers on bolts and thread on 2 elastic stop nuts.
   d. Place flat washers on 2 studs, which protrude thru inner transom plate, and thread on 2 elastic stop nuts.
   e. Thread 2 long cap screws with square flat washers and lockwashers thru remaining holes in inner transom plate into gimbal housing. Square washers should be against transom plate.

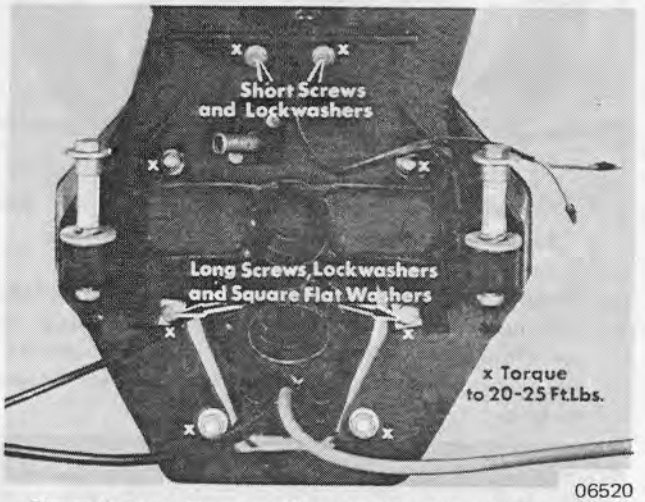

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Figure 6. Inner Transom Plate Positioned on Transom

CAUTION: DO NOT attempt to drive cap screws thru transom, as threads in gimbal housing will be damaged.

3. Tighten cap screws and elastic stop nuts evenly and torque to 20-25 ft. lbs. (2.7mkg-3.45mkg).
4. Mount hydraulic sender assembly on transom plate (Figure 6) with 2 screws and lockwashers and tighten securely.
5. Install exhaust separator (with exhaust elbows attached) to gimbal housing, following:

a. Be certain that mating surfaces on exhaust separator and gimbal housing are clean and that "O" rings are properly seated in grooves. (Figure 7)

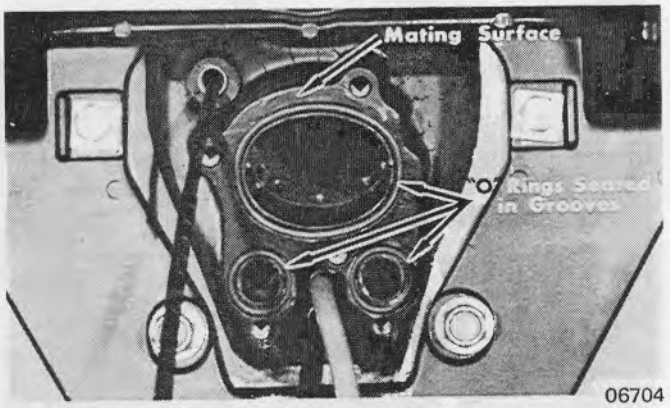

Figure 7. "O" Ring Locations

b. Place 5 hex head screws with lockwashers thru separator into gimbal housing. (Figure 8) Torque screws evenly to 20-25 ft. lbs.

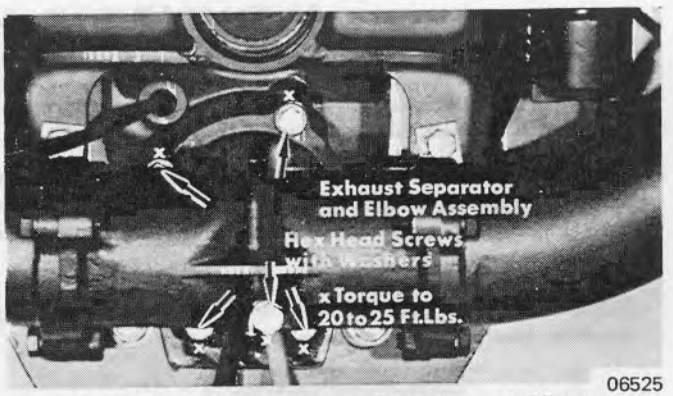

Figure 8. Installing Exhaust Separator and Elbows

CAUTION: Be sure that "O" rings remain seated in grooves to properly seal joint, or leakage will occur.

6. Place hose clamps over each rubber exhaust tube and attach a tube on each cast exhaust elbow. (Figure 9) Tighten tube clamps securely.

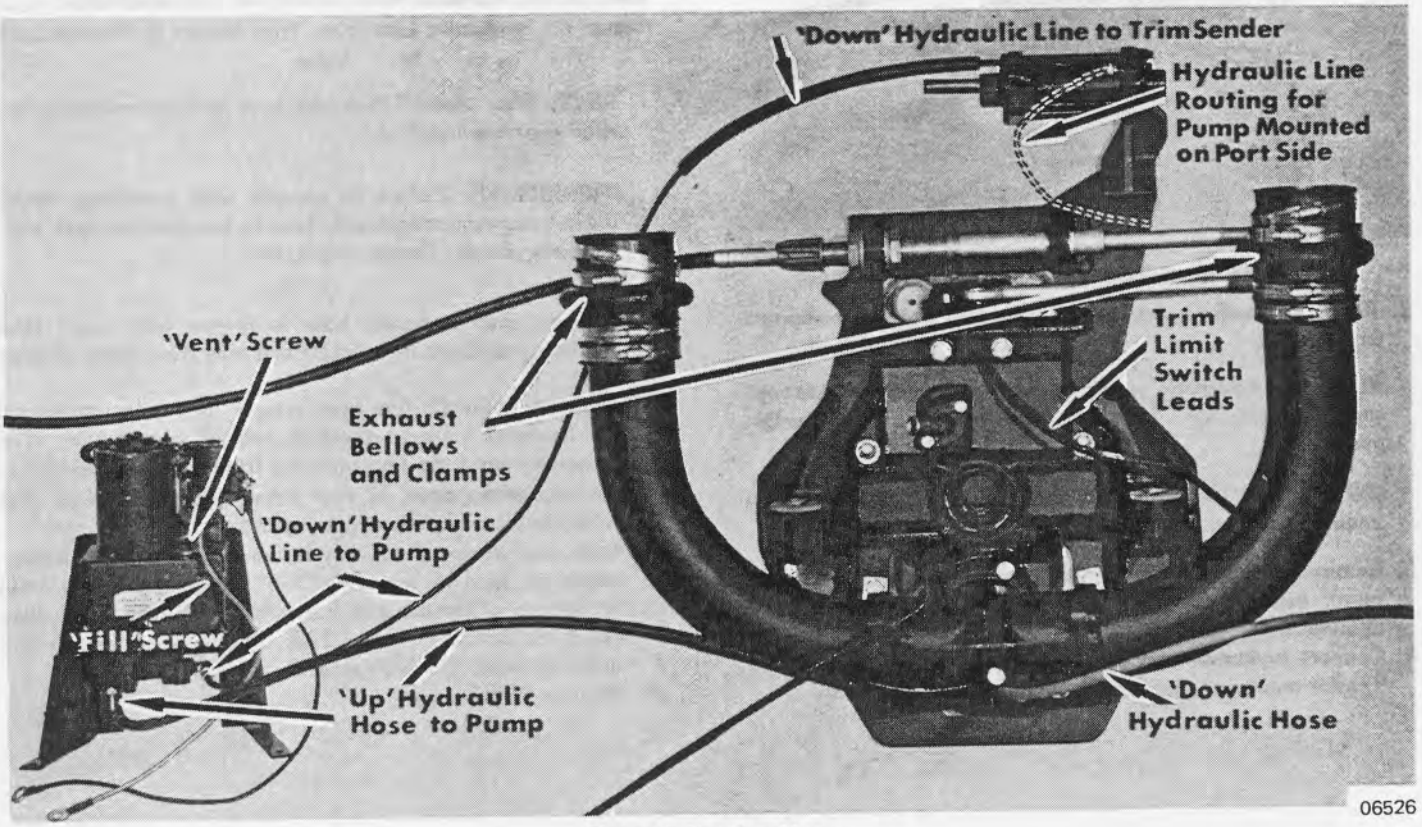

Figure 9. Routing Hoses

MOUNTING HYDRAULIC PUMP

NOTE: Hydraulic pump may be mounted on port or starboard floorboards or on transom.

1. Mount pump to floor of boat with floor mounting bracket and 6 lag screws provided within reach of pump hydraulic lines (Figure 10) or mount pump to transom of boat with transom mounting bracket and 2 carriage bolts provided.

NOTE: The 2 drilled holes for transom pump mounting brackets must be perpendicular to transom.

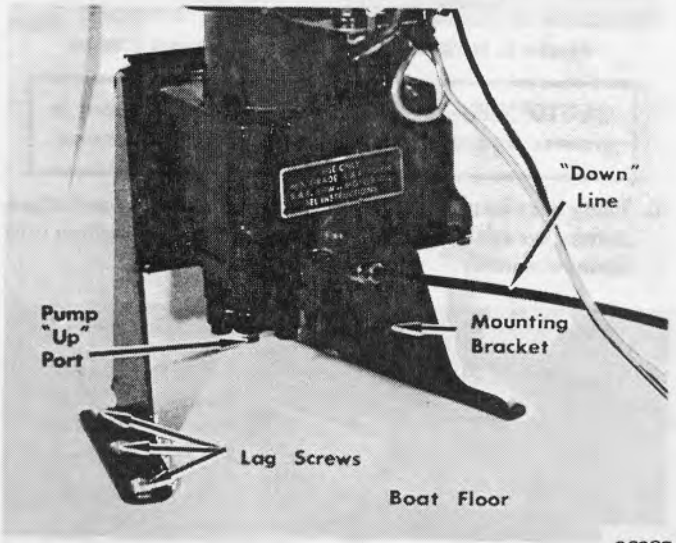

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Figure 10. Typical Mounting Pump to Floor of Boat

2. Route hydraulic hoses toward pump in position as shown in Figure 9.

NOTE: If hydraulic pump is mounted to port side of engine, route "up" hydraulic hose toward the hydraulic pump.

NOTE: DO NOT allow oil to drain thru fittings during connection. Tighten all fittings securely.

3. Remove cap from fitting (located on end of black hydraulic hose), remove threaded plug from hydraulic pump and immediately connect hose.
4. Connect hydraulic line from pump to trim sender (Figure 9) after removing plug from sender and cap from line.

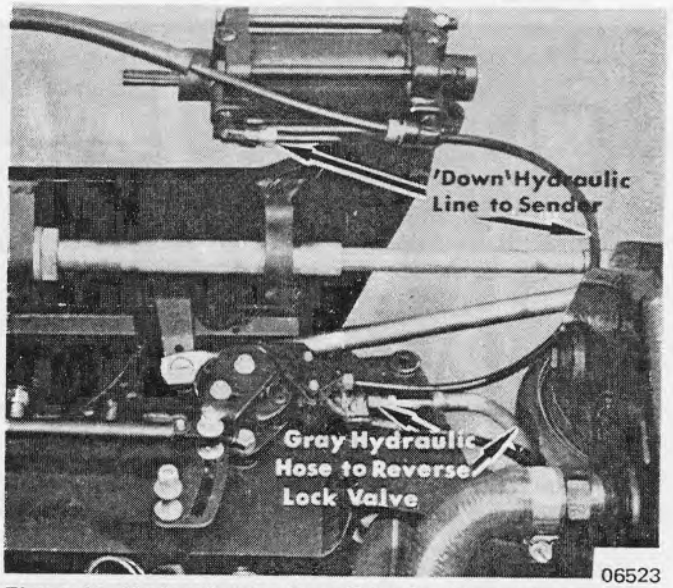

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Figure 11. Hydraulic Line from Trim Sender to Reverse Lock Valve

NOTE: The "down" hydraulic hose and line are connected after engine is installed.

IMPORTANT: Failure to comply with preceding Steps 1-2-3-4 may cause hydraulic hose to become damaged and render hydraulic system inoperative.

5. Connect gray hydraulic hose to reverse lock valve after removing cap from hose fitting and plug from valve. (Figure 11)
6. Connect hydraulic line from reverse lock valve (mounted on flywheel housing) to shaft end of trim sender after removing cap from line and plug from sender. (Figure 11)
7. Loosen pump reservoir vent screw. (Figure 9) Note that vent must be open for proper operation.
8. With unit down all the way in normal operating position, check oil level by removing "Fill" screw. If necessary, fill to bottom of threads with Formula 4 SAE 20W Quicksilver Oil (C-92-33157-1) or an SAE 20-20W specification MS automotive oil. DO NOT overfill.
9. Replace "Fill" screw.

INSTALLING STERN DRIVE UNIT

CAUTION: Check Engine Alignment with Engine Alignment Shaft (C-91-57797A1) before installing Stern Drive Unit.

1. Lubricate shifting slide assembly. (Figure 1)

   NOTE: Slide assembly is free to rotate on core wire, so be sure that slide is located in the upright position during installation.

06530

Figure 1. Lubricating Shifting Slide Assembly

2. Lubricate land on drive shaft housing pilot (Figure 2) and drive shaft splines with New Multipurpose Lubricant (C-92-49588). Apply light coating of lubricant to inside surfaces of bell housing bore.

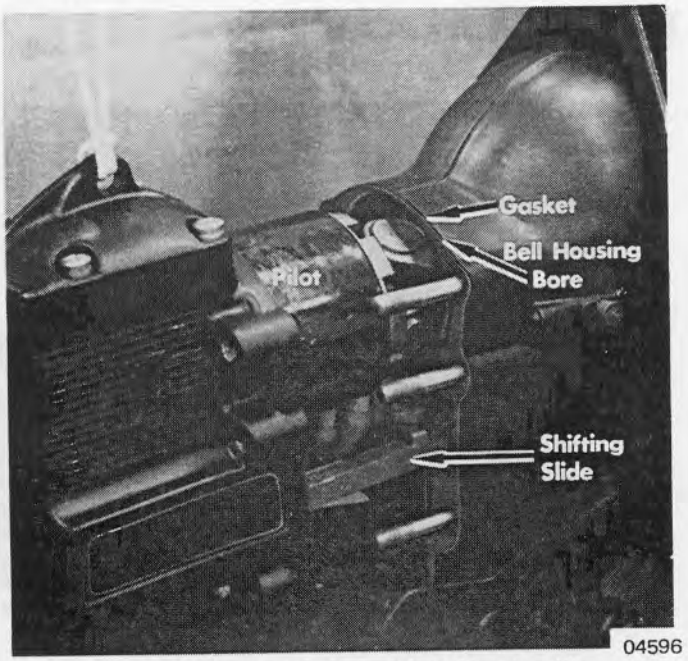

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Figure 2. Lubricating Drive Shaft Housing Pilot

CAUTION: If locating slot of shift lever in bell housing and coupler of intermediate shift shaft in drive shaft housing are not aligned as described in Steps 5 and 6, following, bell housing and shift shaft couplers will be damaged when drive unit is installed.

3. Align locating slot of shift lever coupler in bell housing straight to rear by moving shift lever to the right (facing transom from inside boat) and lubricate slot with Anti-Corrosion Grease (C-92-45134A1). (Figure 3)

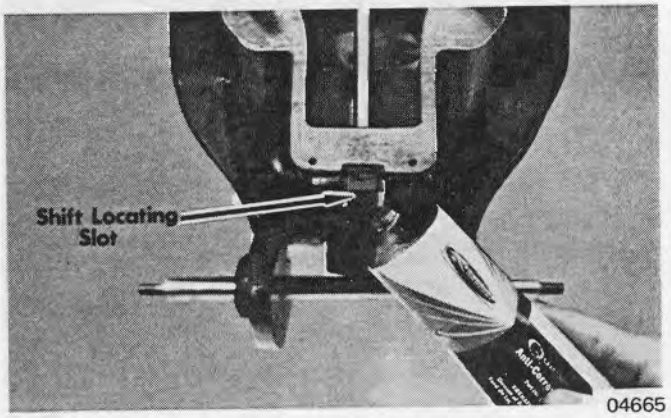

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Figure 3. Lubricating Shift Lever Coupler

4. Align coupler of intermediate shift shaft in drive shaft housing (Figure 4) for straight entry into locating slot of shift lever in gimbal housing.

   NOTE: It may be necessary to rotate propeller shaft to align intermediate shift shaft coupling with upper shift shaft slot.

Drive unit must be in forward gear position. Lubricate coupler surface with Anti-Corrosion Grease. (Figure 4)

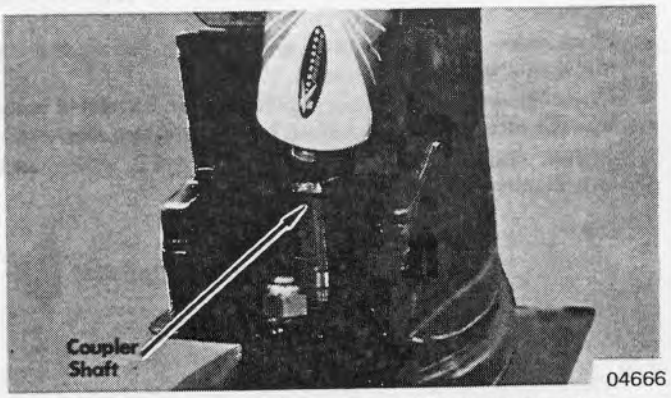

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Figure 4. Aligning Intermediate Shift Shaft Coupler

NOTE: Since the fit between the universal joint "O" rings and gimbal housing ball bearing is tight, it is recommended that a coating of New Multipurpose Lubricant (C-92-49588) be placed on the 2 "O" rings. This will facilitate installation of the universal joint into the gimbal housing ball bearing.

5. Place drive shaft housing gasket on bell housing. (Figure 5)
6. Insert stern drive unit into drive shaft housing bell bore as follows: (Figure 5)
   a. Guide drive shaft thru bearing in gimbal housing into drive coupling on engine while guiding shift slide into opening in drive shaft housing.

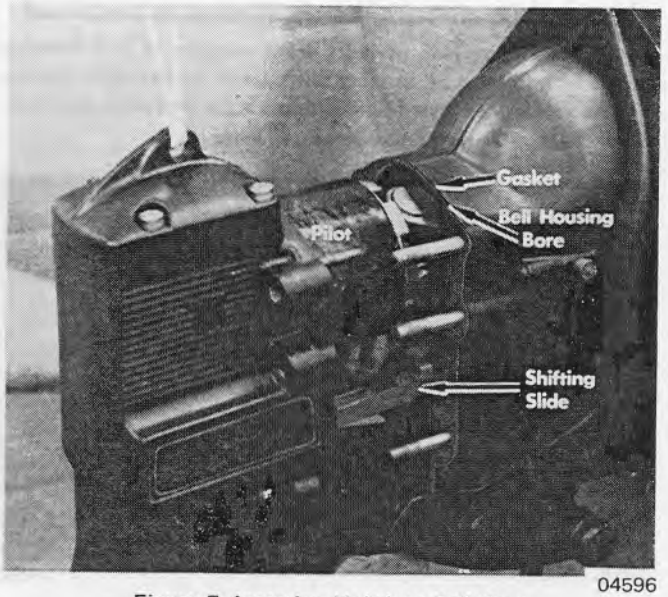


Figure 5. Inserting Unit into Bell Bore

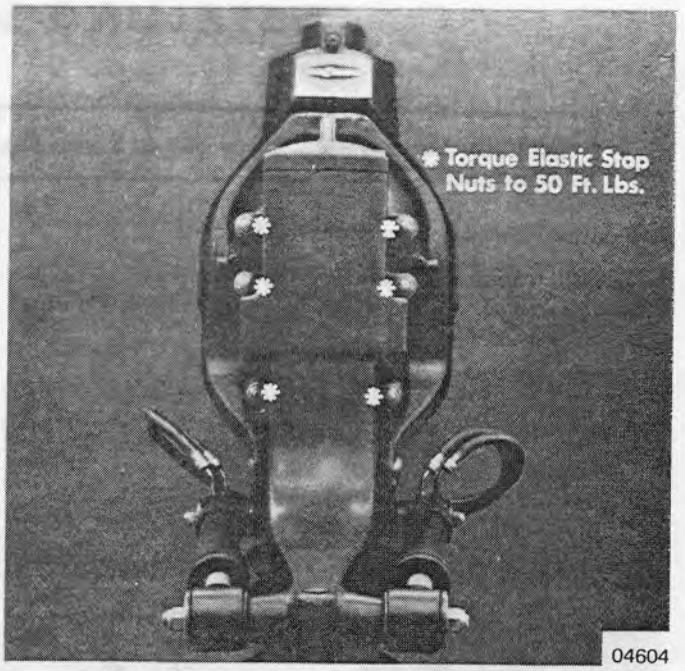


Figure 6. Fastening Drive Shaft Housing to Bell

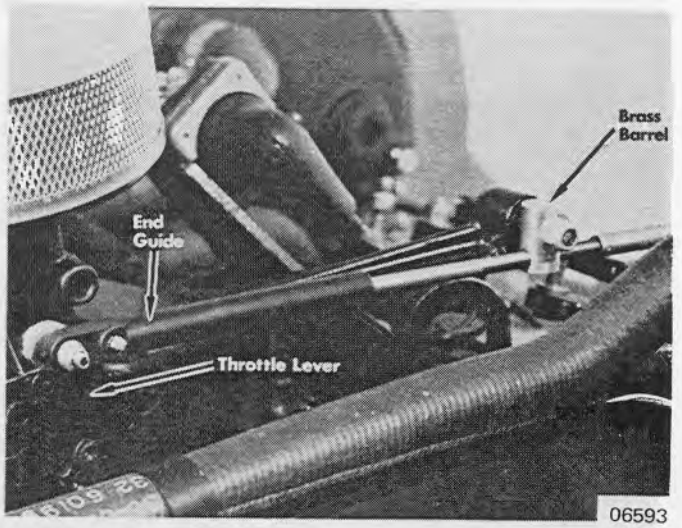
   b. Be careful not to move shift slide assembly or coupler. The unit will not align if out of position. If drive shaft splines do not align with engine coupling splines, rotate propeller shaft counterclockwise until drive unit can be pushed into position. Propeller should be placed on shaft for easier rotation.
7. Fasten drive shaft housing to bell mounting bolts with 6 elastic stop nuts and flat washers. Tighten evenly to 50 ft. lbs. (6.9mkg) torque. (Figure 6)

THROTTLE CABLE INSTALLATION

Before proceeding with the following instructions, throttle and shift cables should be installed in remote control and control mounted in boat. Refer to "Remote Control" Section 7C.

1. Place remote control in neutral gear, idle position.
2. Remove nut and thin washer from screw which passes thru carburetor throttle lever.
3. Place cable end guide over spacer. Place flat washer on screw and tighten nut securely. (Figure 7)
4. Grasp throttle cable at point behind brass barrel and push toward throttle lever. Adjust brass barrel to align with anchor stud. Fasten barrel to stud with flat washer and nut. Tighten nut securely.

Figure 7. Throttle Cable Installed



ATTACHING and ADJUSTING SHIFT CABLE

IMPORTANT: Follow these instructions to ensure full clutch engagement. Before proceeding with the following instructions, install remote control and throttle and shift cables, as outlined in the instructions which accompany the remote control.

IMPORTANT: Remote control shift cable may be installed in two (2) different ways, depending upon location of remote control station. If remote control is mounted on right (starboard) side of boat, proceed with instructions under "A" following. If remote control is mounted on left (port) side of boat, proceed with instructions under "B" following.

A. REMOTE CONTROL MOUNTED on RIGHT SIDE

1. Move shift lever to left (when viewing lever from inside boat) as far as it will go. (Figure 1) This shifts stern drive unit into forward gear. While shifting, turn propeller shaft counterclockwise until shaft stops, to ensure full clutch engagement.

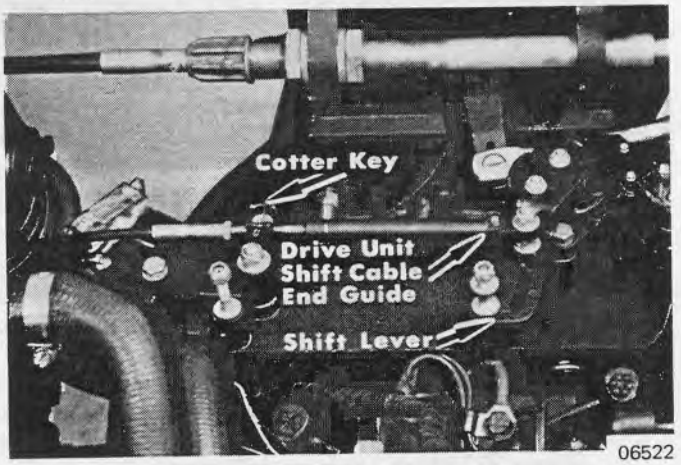


Figure 1. Shifting into Forward Gear

2. Move remote control handle to full forward position.
3. Anchor remote control shift cable end guide to shift lever anchor point. Lightly pull outer conduit away from cable guide (to eliminate slack in cable) and adjust brass barrel on remote control shift cable to align with anchor point. (Figure 2)

Figure 2. Adjusting Brass Barrel

4. Once the brass barrel is positioned on the control shift cable, DO NOT allow it to move from this position when placing remote control handle into full reverse position.
5. Manually move shift lever to right (when viewing lever from inside boat) as far as it will go. (Figure 3) This shifts stern drive unit into reverse. While shifting, rotate propeller shaft clockwise until shaft stops, to ensure full clutch engagement.

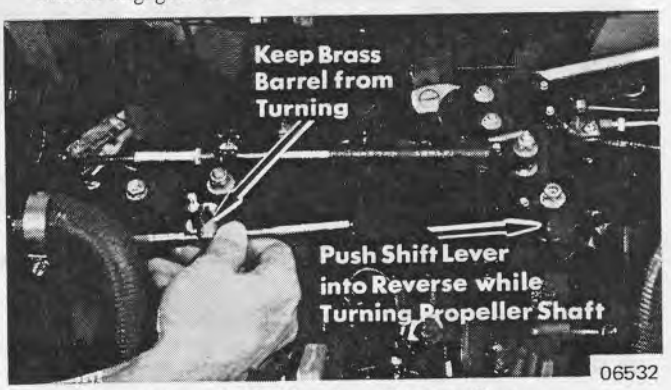


Figure 3. Shifting into Reverse Gear

6. Move end guide of stern drive shift cable in shift lever slot so that brass barrel of control shift cable can be reinstalled on anchor point. (Figure 4)

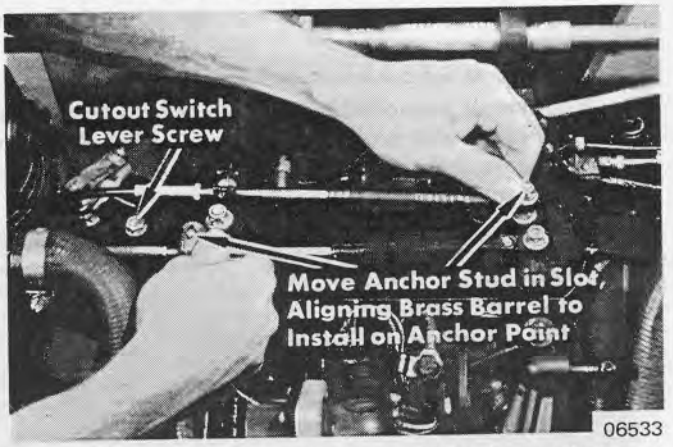


Figure 4. Locating End Guide in Shift Lever Slot and Anchoring Shift Cable

7. Securely tighten nuts which fasten anchor stud to shift lever and brass barrel to anchor point.
8. Reverse lock valve adjustment:
   a. Shift unit into full reverse. While shifting, rotate propeller shaft clockwise until shaft stops, to ensure full clutch engagement.
   b. Loosen 2 nuts on shift lever and move upper nut in direction required to line up raised triangular mark on cam with raised triangular mark on reverse valve cover. (Figure 5) Tighten 2 nuts on shift lever.

CAUTION: Unit may be locked in neutral if reverse lock valve is over-adjusted.

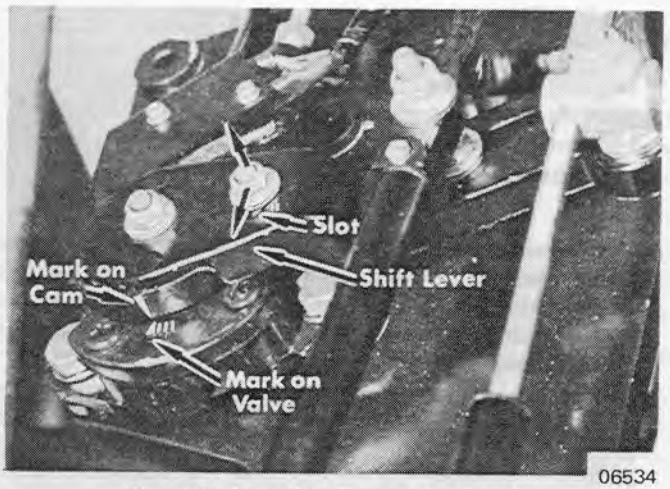


Figure 5. Adjusting Reverse Lock Valve

IMPORTANT: Brass barrel must be positioned on anchor point as shown in Figure 6.

9. Remove screw which extends thru shift cutout switch lever. (Figure 4)
10. This completes installation of shift cable.

B. REMOTE CONTROL MOUNTED on LEFT SIDE

1. Move shift lever to left (when viewing lever from inside boat) as far as it will go. (Figure 1) This shifts stern drive unit into forward gear. While shifting, turn propeller shaft counterclockwise until shaft stops, to ensure full clutch engagement.
2. Move remote control handle to full forward.
3. Hold remote control shift cable end guide to anchor point with washer and stop nut. (Figure 6) Lightly pull outer conduit away from cable guide and adjust brass barrel on remote control shift cable to align with anchor point.

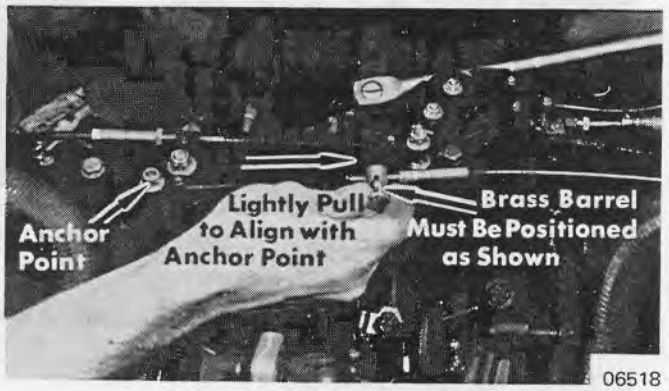


Figure 6. Adjusting Brass Barrel

4. Hold brass barrel to anchor point with spacer, washers and stop nut.
5. Remove stop nut which holds remote control shift cable end guide to anchor point.
6. Move remote control handle to full reverse.
7. Manually move shift lever to right (when viewing lever from inside boat) as far as it will go. (Figure 7) This shifts stern drive unit into reverse. While shifting, rotate propeller shaft clockwise until shaft stops, to ensure full clutch engagement.
8. Move end guide of stern drive shift cable in shift lever slot until control cable end guide can be reinstalled to anchor point. (Figure 8)
9. Securely tighten nuts which fasten anchor stud to shift lever and cable end guide to anchor point.

Figure 7. Shifting into Reverse Gear

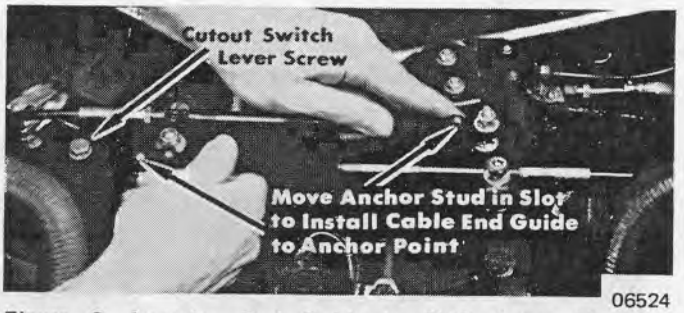


Figure 8. Locating End Guide in Shift Lever Slot and Anchoring Shift Cable

10. Reverse lock valve adjustment:
    a. Shift unit into full reverse. While shifting, rotate propeller shaft clockwise until shaft stops, to insure full clutch engagement.
    b. Loosen 2 nuts on shift lever and move upper nut in direction required to line up raised triangular mark on cam with raised triangular mark on reverse valve cover. (Figure 9) Tighten 2 nuts on shift lever.

> **CAUTION: The unit may be locked in neutral if the reverse lock valve is over-adjusted.**

11. Remove screw which goes thru shift cutout switch lever. (Figure 8)
12. This completes shift cable installation.

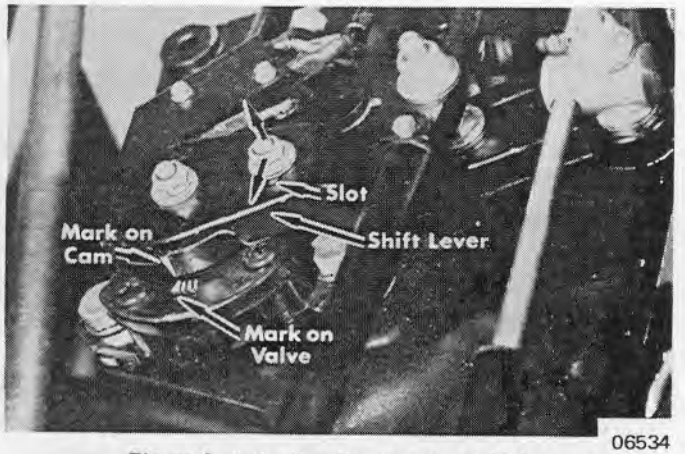


Figure 9. Adjusting Reverse Lock Valve

INSTALLING COMBINATION TRIM and SHOCK CYLINDERS

IMPORTANT: Be sure that one small spiral grounding spring is installed between rubber bushings on each side of both forward and aft anchor pins. (Figure 10) They are necessary to ground the trim cylinders to the stern drive unit in order to reduce galvanic corrosion.

1. Insert forward anchor pin in gimbal ring.
2. Place one flat washer, one rubber washer and one spiral spring on forward anchor pin on each side of gimbal ring.

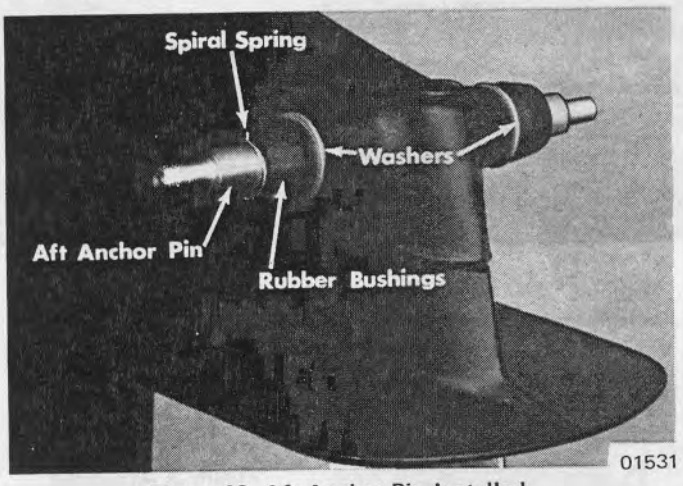


Figure 10. Aft Anchor Pin Installed

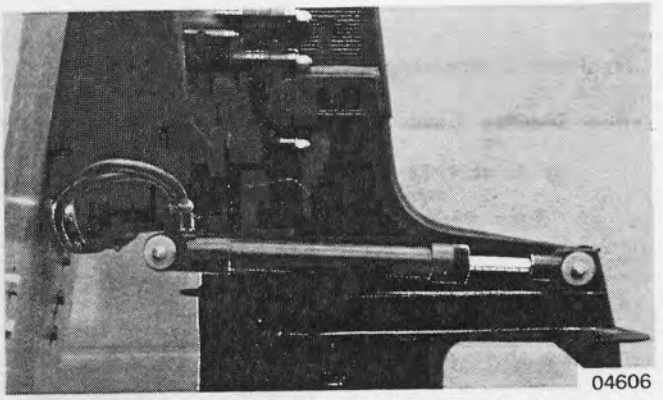


Figure 11. Power Trim Cylinder Installed

3. Insert aft anchor pin thru hole in drive shaft housing and place a large washer, rubber bushing and one spiral spring on aft anchor pin on each side of drive shaft housing. (Figure 10)
4. Place cylinders in position on forward and aft anchor pins.
5. Place one rubber bushing in forward and aft end mounting of each cylinder. Small diameter end of bushings face drive shaft housing.
6. Place one flat washer on each end of both cylinders next to rubber bushings. Thread nuts on anchor pins and tighten securely. (Figure 11)

RIDE-GUIDE STEERING INSTALLATION

1. Connect steering link rod with pivot bolt in rod, flat washer and curved washer to steering lever. (Figure 1) Align curved washer and tighten nut.
2. Lubricate inside of cable guide tube with New Multi-purpose Lubricant (C-92-49588).

NOTE: In order to offset effects of propeller torque, it is recommended that steering wheel be mounted on right (starboard) side of boat. In some cases, depending upon boat construction, it may be necessary to mount steering wheel on left (port) side. Steering cable can be attached to drive unit from either right (Figure 2) or left (Figure 3) side.

3. Insert cable end thru tube and thread large hand-type fastening nut on tube securely. (Figure 2 or 3)

NOTE: To attach steering cable from left, remove Ride-Guide tube and reinstall on transom. (Figure 3)

4. Attach steering link rod to cable end and torque to 12 ft. lbs. (1.7mkg).

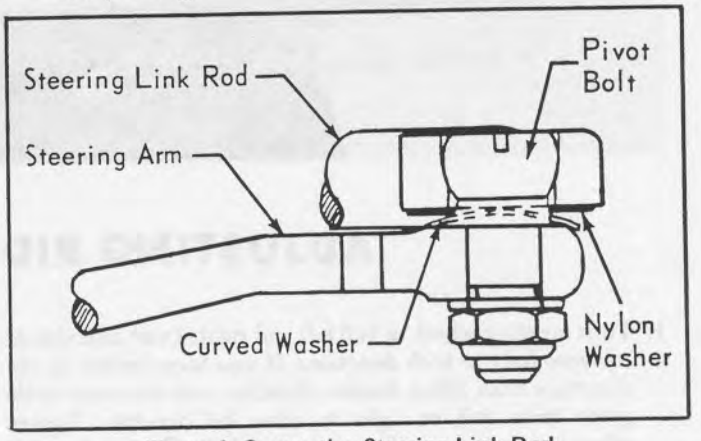


Figure 1. Connecting Steering Link Rod

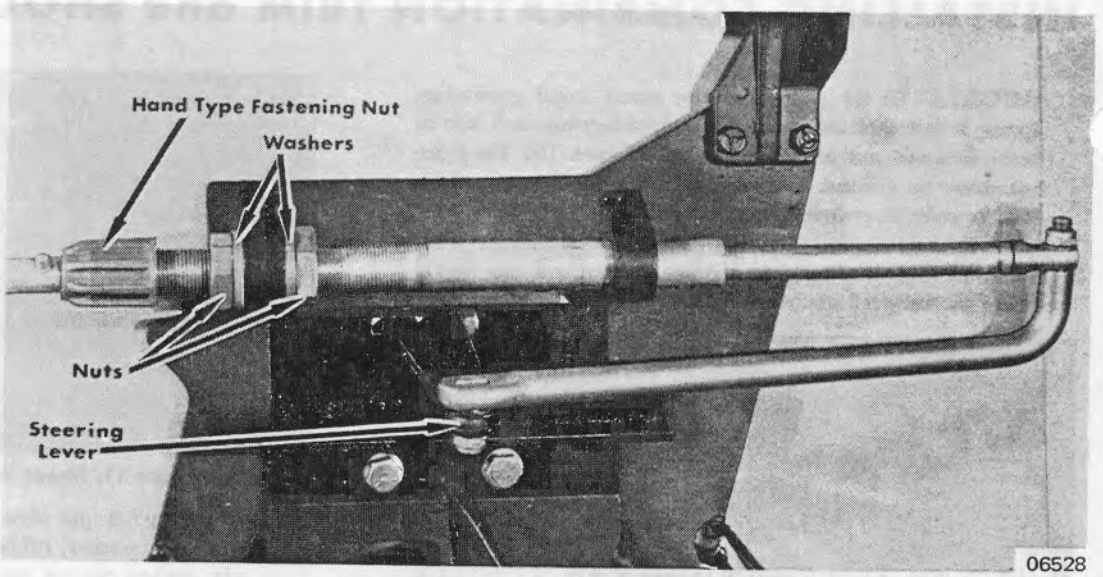


Figure 2. Attaching Steering Cable to Drive Unit from Right

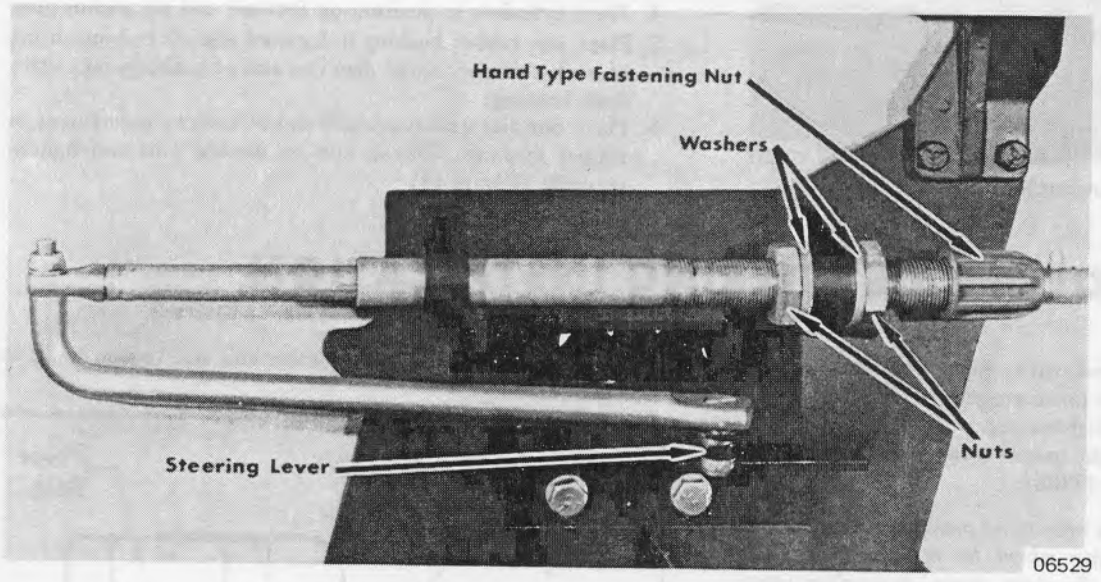


Figure 3. Attaching Steering Cable to Drive Unit from Left

ADJUSTING RIDE-GUIDE STEERING

1. Turn steering wheel to full left and right. Drive unit should traverse fully in both directions. If unit turns further in one direction than other, loosen adjusting nuts and move cable guide tube left or right to allow full traverse. Tighten adjusting nuts securely against bracket. (Figures 2 and 3 under "Ride-Guide Steering Installation," preceding)

2. Turn steering wheel until drive unit is centered. If, at this point, steering wheel is not centered correctly, adjust cable guide tube slightly either way to center steering wheel. Recheck Item 1, immediately preceding, after making the adjustment.

SECTION 2 - REMOVAL, INSTALLATION and ALIGNMENT

MERCRUISER

PART J - II-TR STERN DRIVE

MERCURY MARINE

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MERCRUISER II-TR ENGINE

REMOVAL

IMPORTANT: Stern drive unit must be removed and 6 rear engine mount coupling nuts loosened prior to engine removal. (Figure 1)

1. Disconnect battery cables from battery and remove instrument panel harness connector plug from engine harness receptacle.
2. Disconnect fuel line and throttle cable from engine.
3. Disconnect shift control wires, trim indicator switch wires and hydraulic pump motor wires from engine.
4. Disconnect Power Steering hoses from steering valve assembly and, if equipped, remove Power Trim hoses from reverse lock.

NOTE: Cap hydraulic hoses and plug their connecting passages to prevent loss of hydraulic fluid and dirt and air from entering hydraulic systems.

5. Remove water inlet tube and transom exhaust elbows.
6. Support engine with a suitable sling thru lifting eyes on engine and remove front engine mounting bolts.
7. Pull engine forward to disengage rear engine mount.

CAUTION: DO NOT lift engine until rear mount is disengaged.

8. Remove engine.

INSTALLATION and ALIGNMENT

NOTE: Prior to installing engine, transom plates must be installed as outlined in "Transom Plate Installation", following. DO NOT connect steering link rod to Power Steering cylinder until AFTER engine alignment has been completed.

1. Coat rear mount "O" ring (Figure 1) and gimbal housing opening (Figure 2) with Multipurpose Lubricant (C-92-49588).

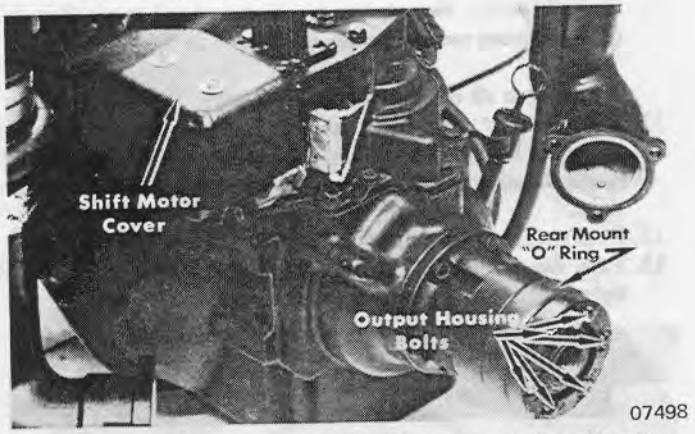

Figure 1. Transmission Output Housing and Rear Mount

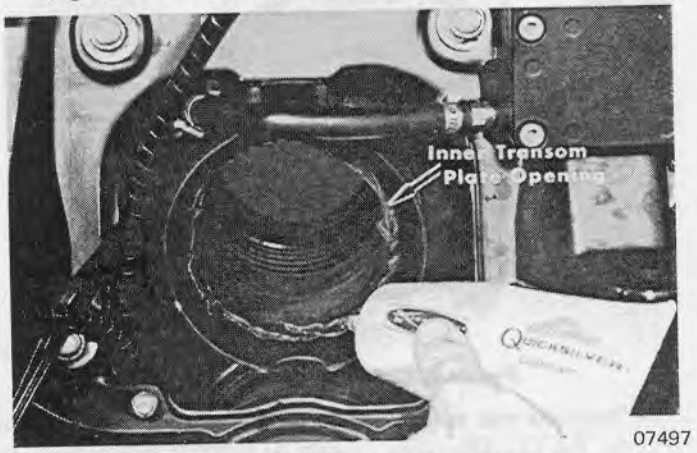

Figure 2. Inner Transom Plate Opening

2. Lift engine with an overheat hoist, using a suitable sling and lifting eyes on engine.

NOTE: Make sure that 6 nuts, which secure bearing retainer to output housing, are loose before installing into gimbal housing.

3. Position engine ahead of inner transom plate so that transmission output housing and rear mount (Figure 1) are in line with large opening in inner transom plate.
4. Move engine toward inner transom plate and, at the same time, guide transmission output housing into gimbal housing opening. Use caution so that transmission output housing and rear mount are not damaged.
5. Relieve hoist tension, as required, to allow transmission output housing to seat in gimbal housing.

IMPORTANT: DO NOT relieve hoist tension entirely at this time, as transmission and output housing may be damaged.

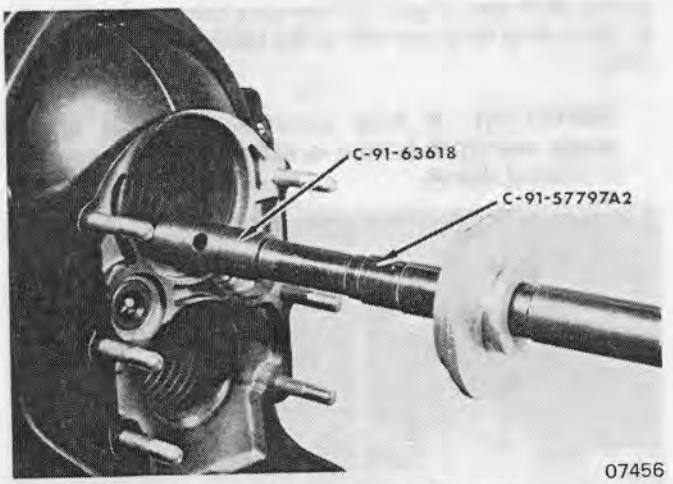

Figure 3. Alignment Tool Location

6. Position plate of Alignment Tool (C-91-57797A3) on shaft, as shown in Figure 3. Thread Extension (C-91-63618) onto alignment shaft. Insert end of alignment tool into opening in bell housing and into transmission output housing. (Figure 3) Insert shaft until it bottoms-out in transmission output housing.
7. Slide alignment plate toward bell housing. Raise or lower front of engine with hoist to allow shoulder on plate to enter bell housing opening. (Figure 4)

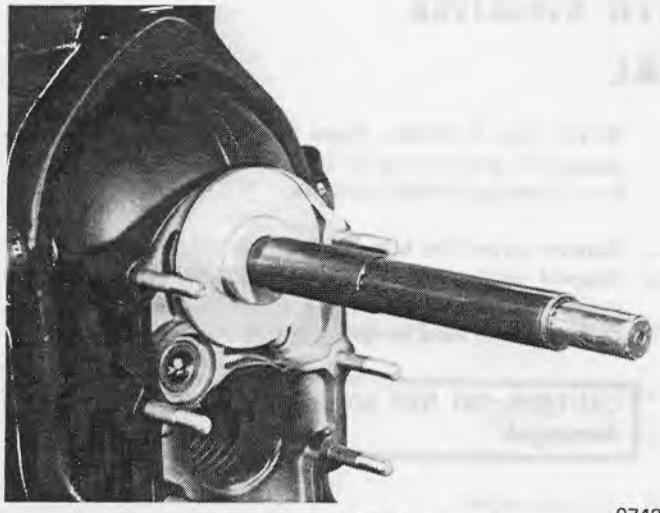

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Figure 4. Tool Plate Installed

8. Front engine mount supports should be constructed so that mounts will rest on top of supports without disturbing alignment tool plate position in bell housing when hoist tension is relieved.
9. Relieve hoist tension entirely and fasten front mount bases to supports with 3/8" diameter bolts, washers and locknuts.

CAUTION: Engine side mounts must be positioned so that engine does not tilt to one side or the other.

10. Push alignment shaft and plate toward engine and, while holding plate against bell housing, check for gap between plate and rear surface of bell housing at 12, 3, 6 and 9 o'clock positions. Engine alignment is correct when there is no gap at any point. If gap exists, proceed as follows:

GAP at 12 O'CLOCK POSITION

Raise front of engine by turning adjusting bolt on both front mounts clockwise. (Figure 5) Turn both bolts an equal amount by alternating from one side to the other until gap no longer exists.

IMPORTANT: If front mount bolts are not adjusted evenly and engine is tilted to one side, damage may occur to exhaust elbows.

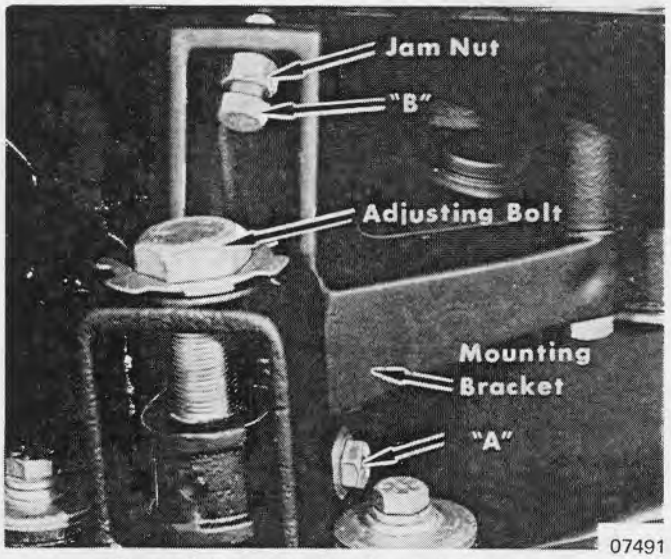

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Figure 5. Front Engine Mount Adjustments

GAP at 6 O'CLOCK POSITION

Lower front of engine by turning adjusting bolt on both front mounts counterclockwise. (Figure 5) Turn both bolts an equal amount by alternating from one side to the other until gap no longer exists.

IMPORTANT: If front mount bolts are not adjusted evenly and engine is tilted to one side, damage may occur to exhaust elbows.

GAP at 3 O'CLOCK POSITION

a. Loosen screw and nut ("A" in Figure 5) on both front mounts.
b. Move front of engine to the right (starboard) until gap no longer exists.

IMPORTANT: Mounts must not extend out more than ¾" (19mm) from mount brackets. (Figure 5)

c. Tighten all mount fasteners securely.

GAP at 9 O'CLOCK POSITION

a. Loosen screw and nut ("A" in Figure 5) on both front mounts.
b. Move front of engine to the left (port) until gap no longer exists.

IMPORTANT: Mounts must not extend out more than ¾" (19mm) from mount brackets. (Figure 5)

c. Tighten all mount fasteners securely.

11. After correct alignment has been attained, bend tabs of adjusting bolt tab washers down over edges of mounts and re-check all mount fasteners to make sure that they are tight.
12. Remove alignment shaft and plate.
13. Turn cap screw "B" finger-tight against cylinder block and tighten jam nut. (Figure 5)

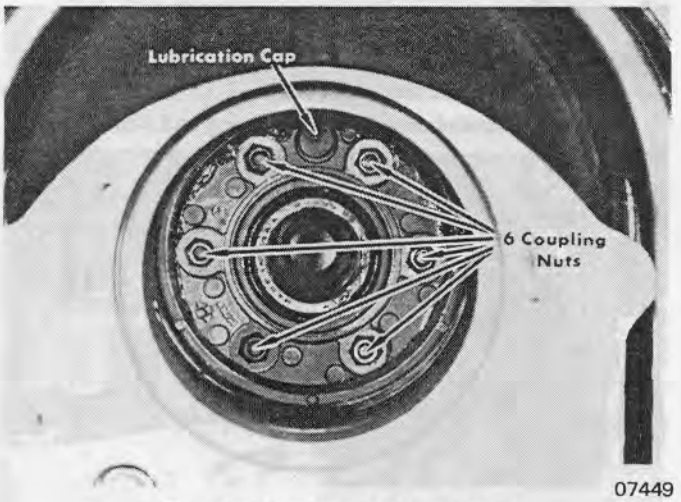

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Figure 6. Coupling Nut Location

14. Torque 6 rear mount compression stud nuts evenly to 70 in. lbs. (12.43kg/cm). (Figure 6) Remove lubrication cap (Figure 6) and lubricate output bearing with Multipurpose Lubricant (C-92-49588).
15. Connect all wires and hoses which were disconnected in removal. Install transom exhaust elbows and water inlet.

STERN DRIVE UNIT INSTALLATION/REMOVAL (For Removal, Reverse the Following Procedure.)

CAUTION: Before installing stern drive unit, engine installation and alignment MUST BE completed and the rear mount retaining nuts tightened to 70 in. lbs. (12.43kg/cm).

1. Lubricate the following with Multipurpose Lubricant (C-92-49588): Drive shaft housing pilot (Figure 1), "O" ring and U-joint shaft end (internally and externally). Apply a light coat of lubricant to inside surfaces of bell housing bore. Position bell housing gasket. (Figure 2)
2. Place forward anchor pin in gimbal ring. (Figure 2)

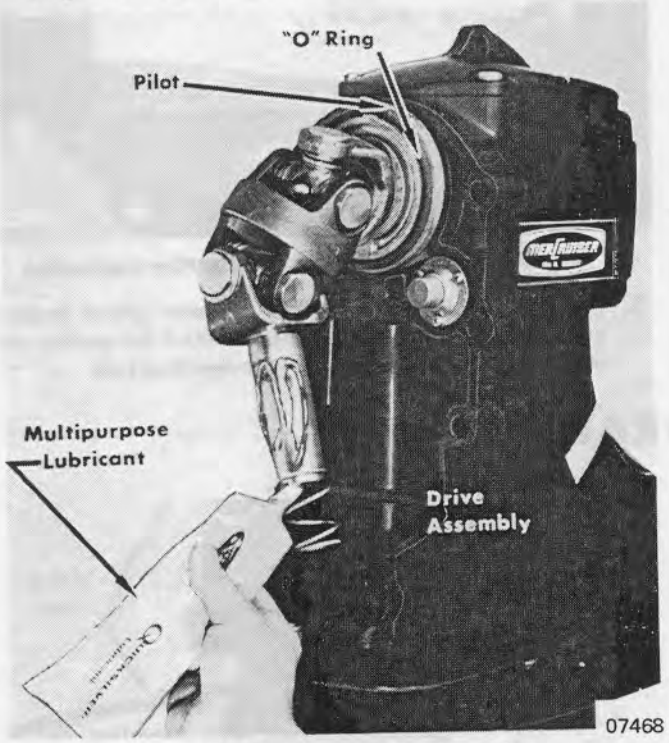


Figure 1. Installation Lubrication Points

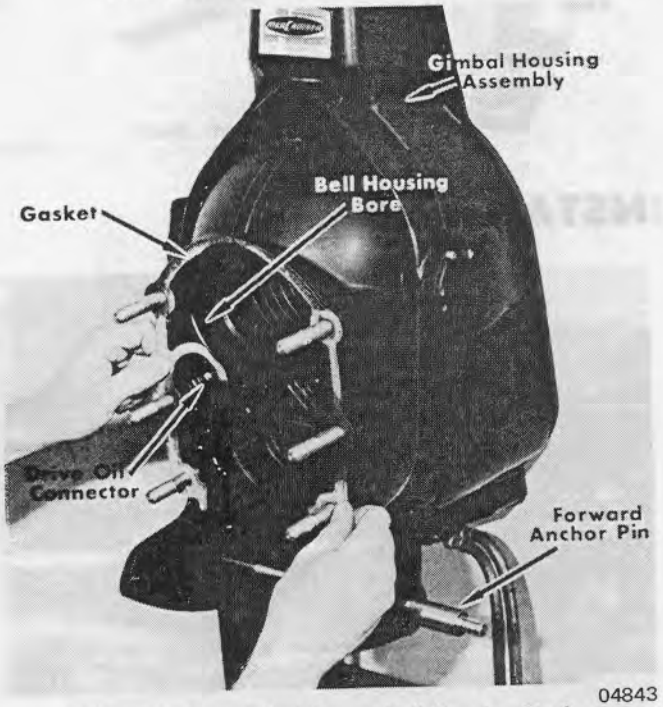


Figure 2. Gasket Position on Bell Housing Studs

NOTE: Use hoisting equipment to hold drive during installation.

3. Insert stern drive unit into bell housing bore (Figure 3) by guiding universal joint shaft thru pilot bearing.
4. Push drive shaft housing completely into bell housing (Figure 3) and fasten with 6 elastic stop nuts and flat washers. Torque evenly to specifications.

Figure 3. Inserting Drive Unit into Gimbal Housing

NOTE: If universal joint shaft splines do not align with transmission splines, rotate propeller shaft slightly until drive can be pushed into bell housing.

5. Fill drive unit with fresh Super-Duty Gear Lubricant (C-92-52650-12, tubs; C-92-52655-12, cans; C-92-52645, 25 lb. pails). Fill thru lubricant filler hole in gear housing until lubricant appears at vent hole in drive shaft housing. Install vent screw in drive shaft housing. Continue to fill drive unit until lubricant registers on dipstick in transom plate oil reservoir.

NOTE: DO NOT fill transom plate oil reservoir thru dipstick tube. Air will be trapped in the system.

TRANSOM PLATE INSTALLATION

1. Lubricate exhaust tube "O" ring in gimbal housing assembly (Figure 4) and inner transom plate exhaust pilot with Multipurpose Lubricant (C-92-49588). (Figure 5)

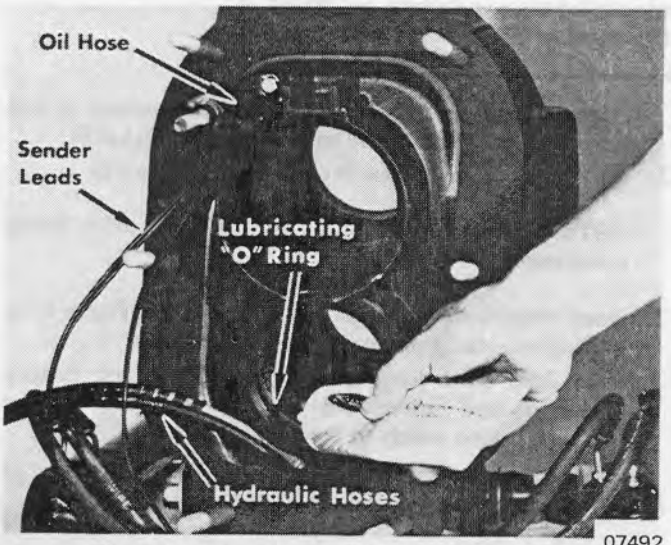


Figure 4. Exhaust Tube "O" Ring Lubrication

Position gimbal housing and inner transom plate into transom holes and insert switch leads, hydraulic hoses, unit oil hose and steering link rod thru openings.

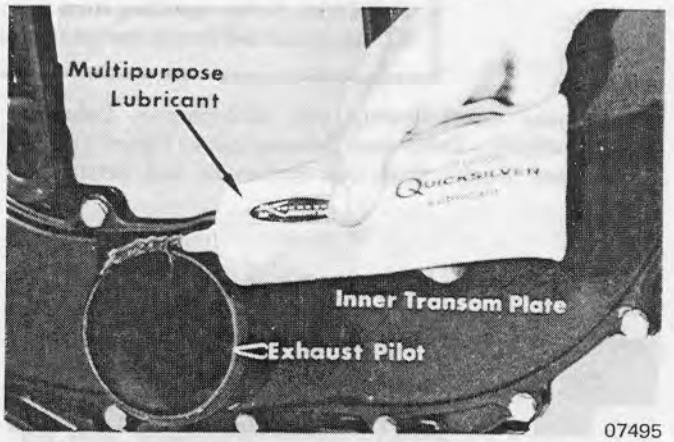


Figure 5. Inner Transom Plate Exhaust Pilot Lubrication

2. Hold gimbal housing in position. Fasten gimbal housing and inner transom plate to transom with 8 flat washers and stop nuts, torquing them evenly to specifications.

INSTALLING HYDRAULIC PUMP

1. Mount pump to floor on right side of boat with floor mounting bracket and 6 lag screws (Figure 6) within reach of pump hydraulic lines.
2. For hydraulic hose installation, refer to "Installing Hydraulic Hoses and Wiring", following.

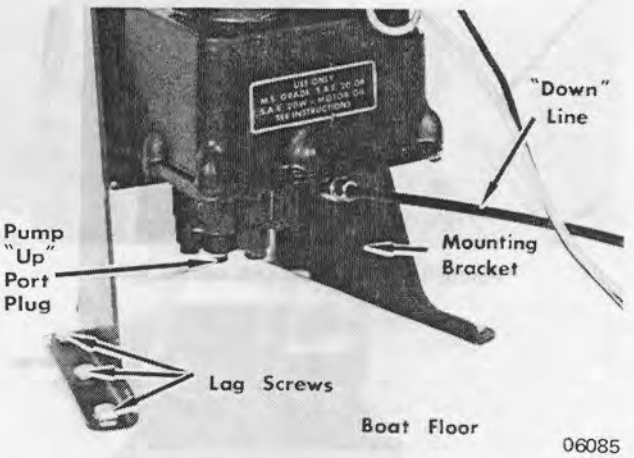


Figure 6.
Locating and Mounting Hydraulic Pump Bracket

THROTTLE CABLE INSTALLATION

1. Place remote control handle in neutral gear, idle position.
2. Connect cable end guide to throttle lever with screw, bushing, washers and nut. (Figure 7)
3. Grasp cable behind brass barrel and push lightly toward throttle lever. Adjust brass barrel to align with anchor stud and fasten barrel to stud with washers and nut. (Figure 7)

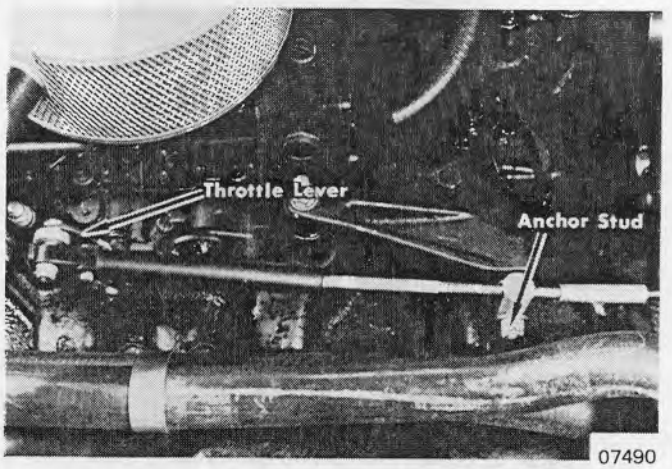


Figure 7. Throttle Cable Installed

SHIFT CONTROL WIRING CONNECTIONS

IMPORTANT: Battery cables must be disconnected from battery prior to connecting shift control wiring to shift motor.

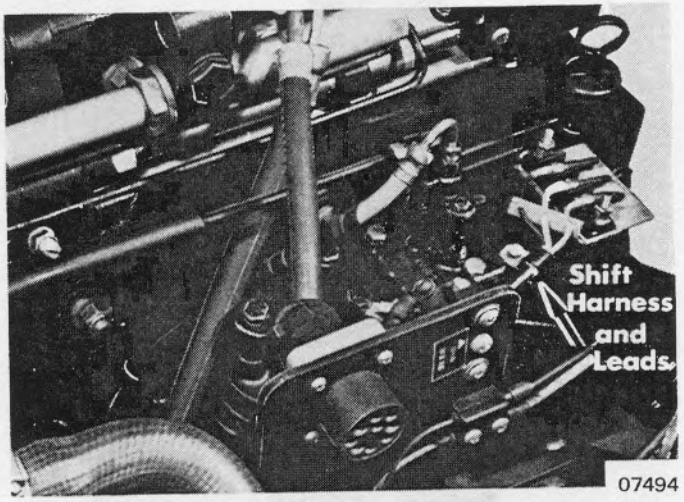


Figure 8. Shift Control Wiring Connections

1. Remove shift motor cover.
2. Connect ring terminals (located on shift control harness) to terminals on shift motor, matching lead and terminal colors. Fasten harness clamp to shift motor bracket. (Figure 8) Reinstall cover.

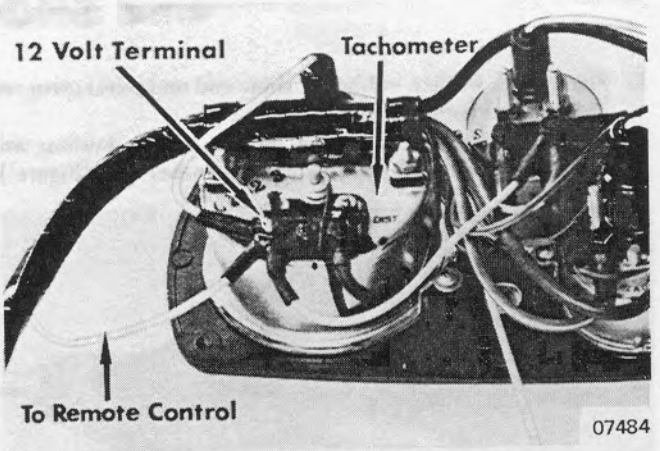


Figure 9. Remote Control Connection

3. Connect white wire from remote control to 12-volt terminal (with white lead) on tachometer. (Figure 9) Use nut and insulating cap.

INSTALLING COMBINATION TRIM and SHOCK CYLINDERS

1. Place a flat washer, rubber bushing and one spiral spring on each side of forward anchor pin.
2. Install aft anchor pin, large washer, rubber bushing and one spiral spring on each side of aft anchor pin. (Figure 1)

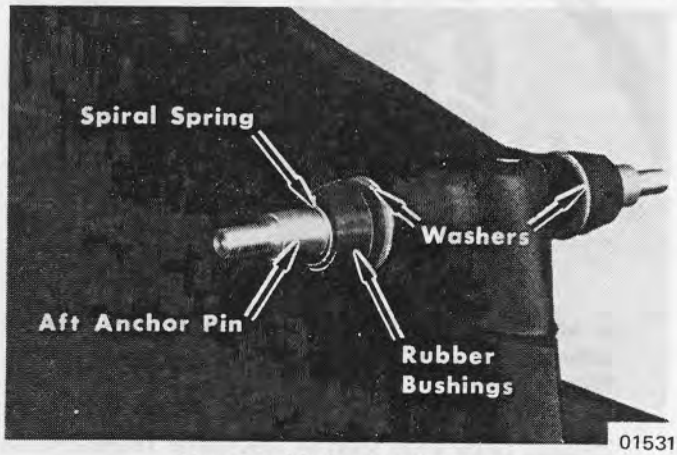


Figure 1. Aft Anchor Pin Installed

NOTE: Make sure that one small spiral spring is installed between rubber bushings on each side of both forward and aft anchor pins. (Figure 1) Springs are required to ground cylinders to drive.

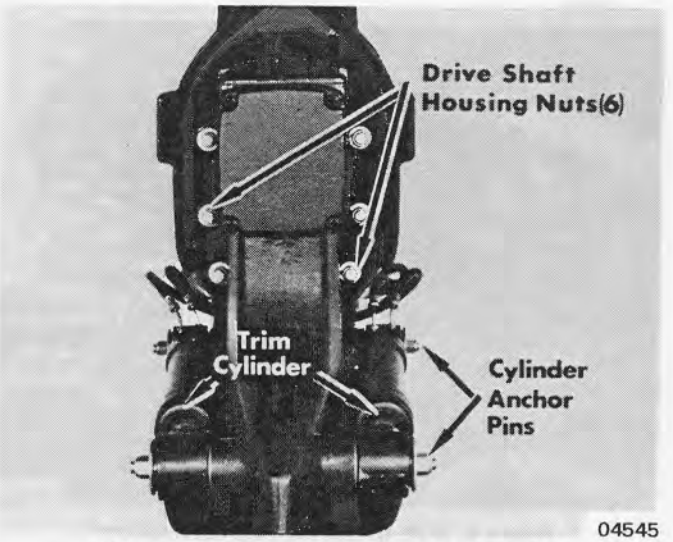


Figure 2. Drive and Trim Cylinders Installed

3. Place cylinders on anchor pins.
4. Place rubber bushings in forward and aft end of each cylinder.
5. Place flat washer on each end of both anchor pins. Install nuts and tighten securely. (Figure 2)

INSTALLING HYDRAULIC HOSES and WIRING

1. Connect "Up" (black) hose to front of hose connector and "Down" (gray) hose to aft end of the hose connector. (Figure 3)
2. Install hydraulic hose connector onto gimbal housing with gasket. Torque to specifications. (Figure 3)
3. Install 4 short hydraulic hoses to hose connector (Figure 3).
4. Connect 2 hydraulic hoses from front of hose connector to "Up" (front) port on trim cylinders. (Figure 3)
5. Connect 2 remaining hydraulic hoses from aft end of hose connector to "Down" (aft) port of trim cylinders. (Figure 3)

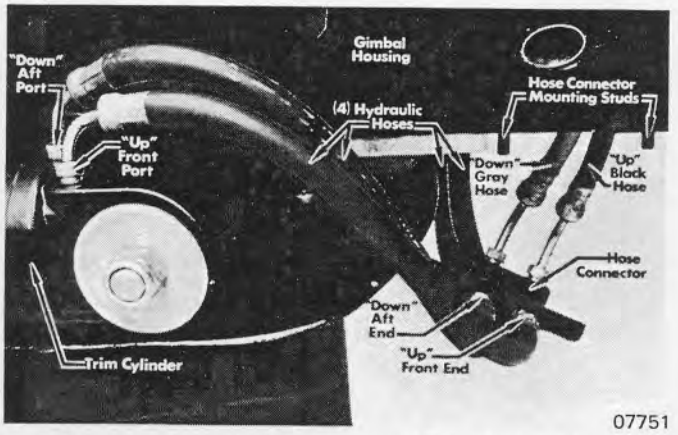


Figure 3. Hydraulic Connector and Trim Cylinders Hoses

6. Connect "Up" (black) hose from gimbal housing hose connector to hydraulic pump. (Figure 4)
7. Connect "Down" (gray) hose from gimbal housing hose connector to reverse lock valve. (Figures 4 and 5)

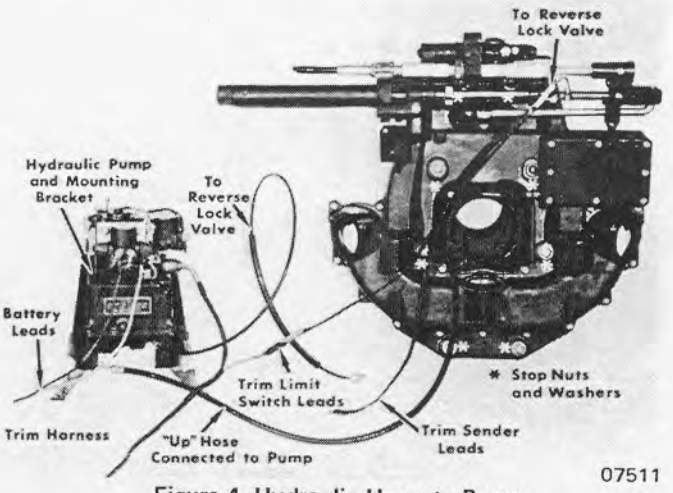


Figure 4. Hydraulic Hoses to Pump

8. Connect "Down" (black plastic) hose from hydraulic pump to reverse lock valve. (Figures 4 and 5)
9. Plug trim control panel wiring harness quick disconnect onto hydraulic pump motor. (Figure 4)
10. Plug trim limit switch leads into trim harness. (Figure 4)

11. Plug trim sender leads into quick disconnect on engine flywheel housing. (Figure 4)
12. Connect red battery lead to battery positive (+) terminal and black to battery negative (-) terminal.

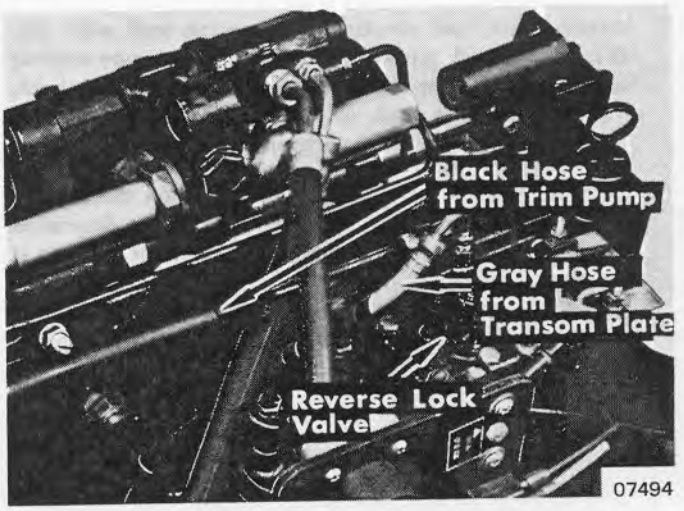


Figure 5. Hydraulic Hoses to Reverse Lock

MOUNTING STEERING UNIT to TRANSOM PLATE

1. Apply thin coat of Quicksilver Multipurpose Grease (C-92-49588) to attaching and mounting parts of Power Steering unit during assembly.
2. Install mounting tube thru transom bosses, thread locknut fully onto tube and tighten. Refer to Figure 6 for right side mounting. For left side mounting, install mounting tube from right and position steering link rod to the right. (Figure 7 for left side mounting)

NOTE: Left side Power Steering unit is installed on opposite side in same manner.

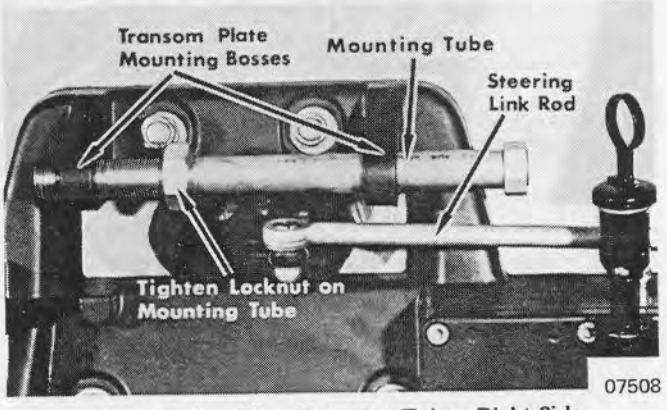


Figure 6. Installing Mounting Tube - Right Side

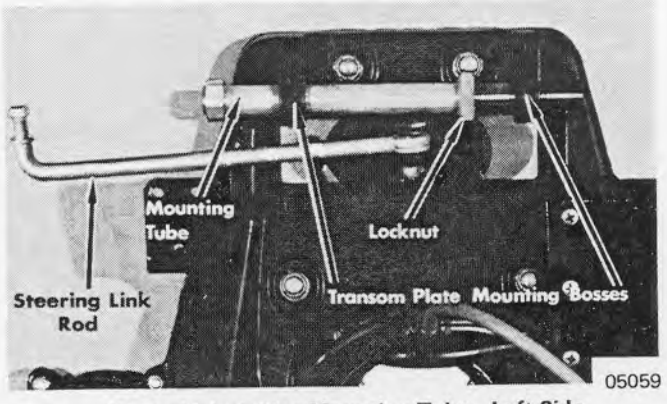


Figure 7. Installing Mounting Tube - Left Side

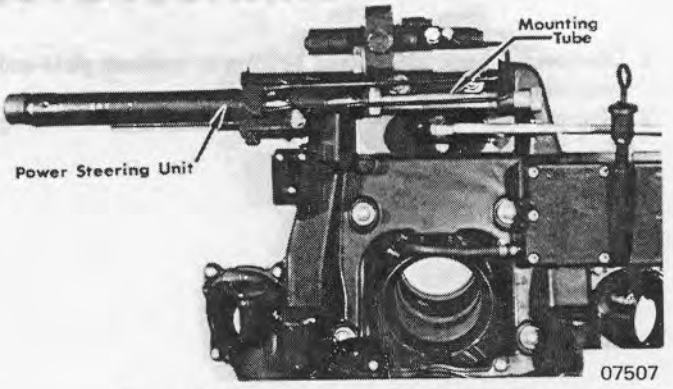


Figure 8. Mounting Power Steering Unit

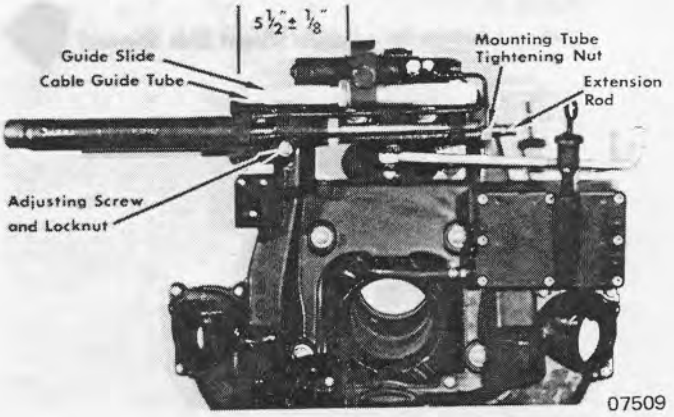


Figure 9. Initial Setting

3. Grease Power Steering extension rod with Multipurpose Lubricant and slip thru mounting tube. (Figure 8) Thread mounting tube into Power Steering unit until locknut bottoms against transom boss. (Figure 9) Tighten securely, using nut on end of mounting tube.
4. Turn adjusting screw in firmly against transom and secure locknut. (Figure 9) Place guide slide over cable guide tube. (Install from other direction on left side Power Steering unit.)

5. Attach cable end adaptor to extension rod with pin. (Figure 10) Lock pin with cotter key, then secure steering link rod to adaptor inside hole with washer and locknut. Tighten nut, then back off ¼-turn. (Install from other direction on left side Power Steering unit.)

IMPORTANT: If pump lugging occurs when the cable is fully extended from the Ride-Guide tube, the dimension (shown on Figure 9) must be checked and corrected if necessary.

NOTE: For valve balancing and other adjustments, refer to Section 7B.

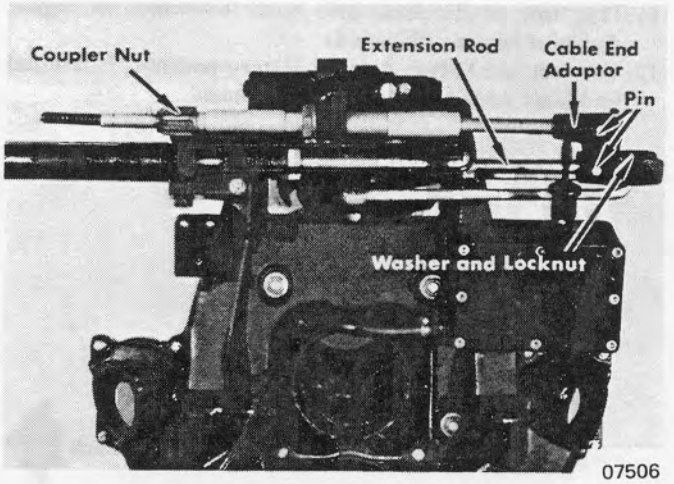


Figure 10.
Extension Rod and Link Rod Attached to Cable End Adaptor

ELECTRICAL WIRING

NOTE: Refer to "Electrical System", Section 3.

EXHAUST SYSTEM INSTALLATION

1. Connect exhaust elbows and bellows to transom plate and manifold elbows as shown in Figure 11.
2. Torque exhaust elbows to transom plate screws according to "Specifications".

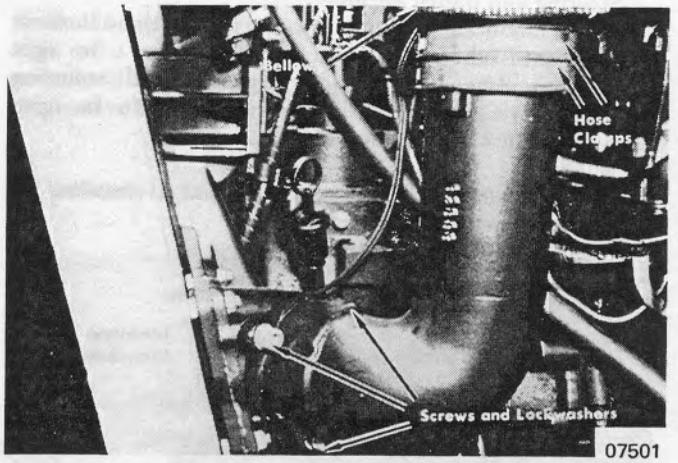
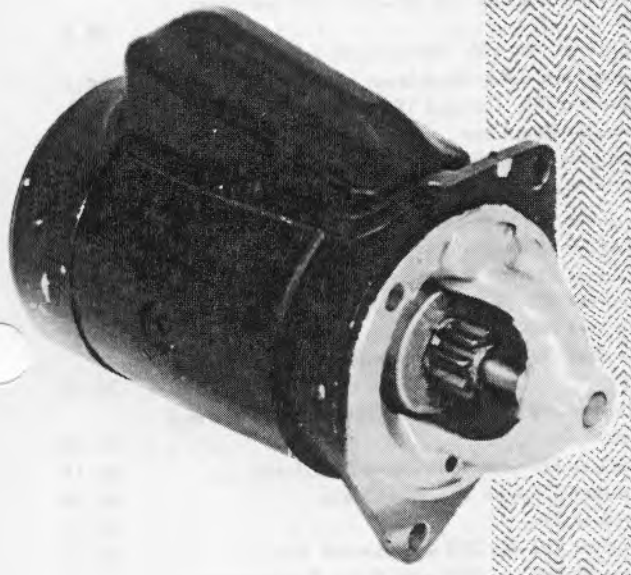
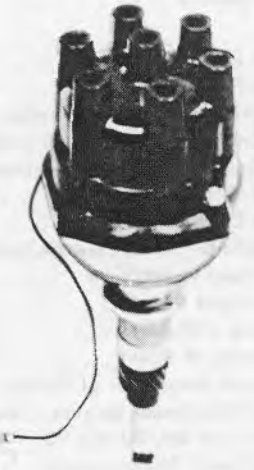
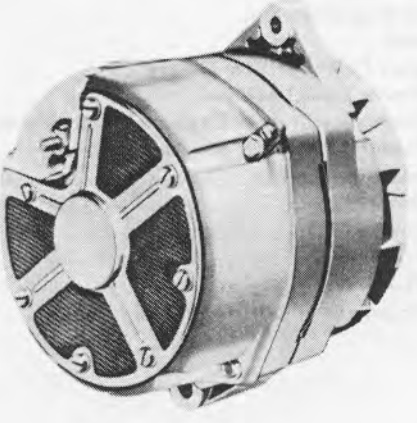


Figure 11.
Exhaust System Installation (Right Side Shown)

MERCRUISER
SECTION 3







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SECTION 3 - ELECTRICAL SYSTEM

MERCRUISER

PART A - STARTING SYSTEM

MERCURY MARINE

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STARTER MOTOR - DELCO REMY

DESCRIPTION

The function of the starting system is to crank the engine. The battery supplies electrical energy to the solenoid which closes the circuit between the battery and cranking motor, causing the cranking motor armature to rotate. The solenoid also shifts the cranking motor pinion into mesh with the flywheel teeth, and engine cranking takes place.

COMPONENTS

The starting system consists of (1) the starting motor, which is a pad-mounted 12-volt extruded frame type with 4 fields connected in series and an armature, (2) a solenoid, a flange-mounted switch which operates an overrunning clutch drive, (3) a battery and (4) the necessary wiring to connect these components. (Figure 1)

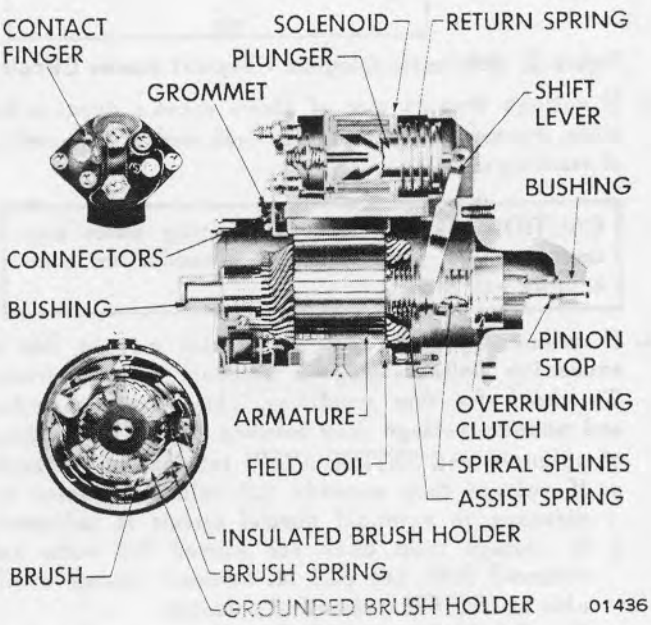

Figure 1. Starting Motor Cross Section

PRECAUTIONS

The cranking motor is designed to operate under great overload and produce a high horsepower for its size. It can do this only for a short time, since considerable heat accumulates and can cause serious damage. For this reason, the cranking motor never must be used for more than 30 seconds at any one time. Cranking should not be repeated without a pause of at least 2 minutes to permit the heat to escape.

PERIODIC INSPECTION

Cranking motor and solenoid are completely enclosed in the drive housing to prevent entrance of moisture and dirt. However, as an aid to preventive maintenance, periodic inspection is required as follows:

1. Inspect terminals for corrosion and loose connections.
2. Inspect wiring for frayed and worn insulation.
3. Check mounting bolts for tightness.

TROUBLESHOOTING

Starting motor specifications cannot be checked while starting motor is mounted on engine, however, starting system can be checked for excessive resistance in starting circuit which could cause battery to run down.

RESISTANCE CHECK

1. Place V-O-A Tester (C-91-52751) across points in cranking circuit, as outlined, following.
2. Observe reading with starting switch closed and motor cranking. Ground distributor primary lead to prevent engine firing.
   a. From battery positive (+) post to solenoid battery terminal (Figure 2)
   b. From battery negative (-) post to starting motor housing
   c. From solenoid battery terminal to solenoid motor terminal

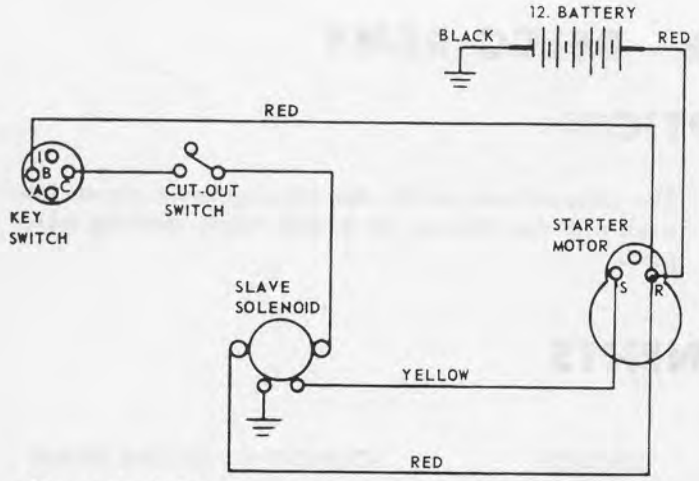

Figure 2. Schematic Diagram - Typical Starter Circuit

3. If voltage drop in any of above checks exceeds 0.2 volts, excessive resistance is indicated in that portion of starting circuit.

> **CAUTION: Do not operate starting motor continuously for more than 30 seconds, as overheating will result.**

4. If solenoid fails to pull in, trouble may be due to excessive voltage drop in solenoid control circuit. To check for this condition, close starting switch and measure voltage drop between BATTERY terminal of solenoid and SWITCH ("S") terminal of solenoid.
   a. If voltage drop exceeds 3.5 volts, excessive resistance in solenoid control circuit is indicated.
   b. If voltage drop does not exceed 3.5 volts and solenoid does not pull in, measure voltage available at SWITCH terminal of solenoid.
   c. If solenoid does not feel warm, it should pull in whenever voltage at SWITCH terminal is 7.7 volts or more. If solenoid feels warm, it will require a somewhat higher voltage to pull in. (Figure 3)

STARTING MOTOR and SOLENOID CHECK

Following checks may be made if battery's specific gravity is 1.215 or higher.

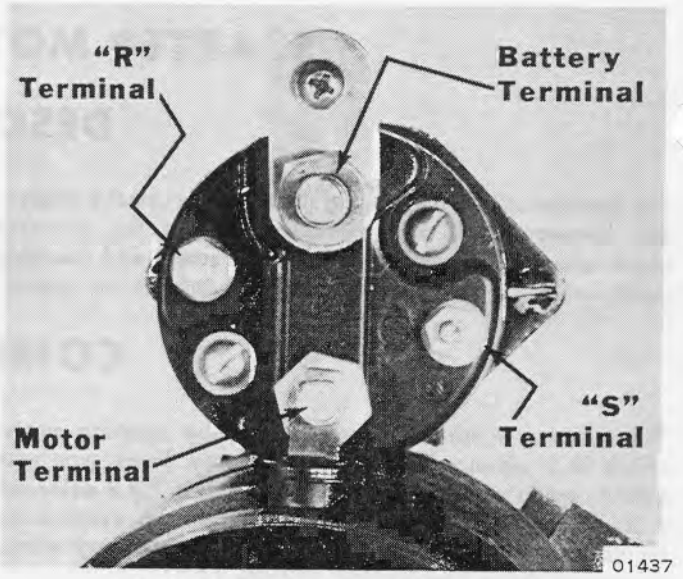

Figure 3. Starter Solenoid Terminals

1. If solenoid does not pull in, measure voltage between SWITCH ("S") terminal of solenoid and ground with starting switch closed.

> **CAUTION: If solenoid feels warm, allow to cool before checking.**

   If voltage is less than 7.7 volts, check for excessive resistance in solenoid control circuit. If voltage exceeds 7.7 volts, remove starting motor and check (1) solenoid current draw, (2) starting motor pinion clearance and (3) freedom of shift lever linkage.
2. If solenoid "chatters" but does not hold in, check solenoid for open "hold-in" winding. When necessary to replace a starting motor solenoid, always check starting motor pinion clearance.
3. If motor engages but does not crank or cranks slowly, check for excessive resistance in external starting circuit, trouble within starting motor or excessive engine resistance to cranking.

1 Housing	18 Coil, shunt	35 Lever, shift	52 Nut
2 Bushing	19 Washer, leather	36 Shaft	53 Stud
3 Collar, thrust	20 Frame	37 Ring	54 Stud
4 Ring, retaining	21 Bolt	38 Stud	55 Washer
5 Collar	22 Bolt	39 Lockwasher	56 Nut
6 Drive Assembly	23 Holder	40 Nut	57 Lockwasher
7 Bushing	24 Holder	41 Plunger	58 Nut
8 Spring	25 Brush	42 Pin	59 Stud
9 Collar	26 Screw	43 Spring	60 Clip
10 Lockwire	27 Support Package	44 Screw	61 Washer, plastic
11 Spring	28 Pin	45 Sol. Switch Ass'y	62 Nut
12 Armature	29 Lead	46 Con. & P. Rod Ass'y	63 Lockwasher
13 Insulation	30 Screw	47 Spring	64 Screw
14 Shoe, pole	31 Lockwasher	48 Cover	65 Washer
15 Screw	32 Nut	49 Stud	66 Screw
16 Grommet	33 Spring	50 Contact	67 Lockwasher
17 Field Coil Assembly	34 Pin, dowel	51 Lockwasher	68 Connector

(Legend for Figure 4 - 60, 80, 90 and 215E Starting Motor)

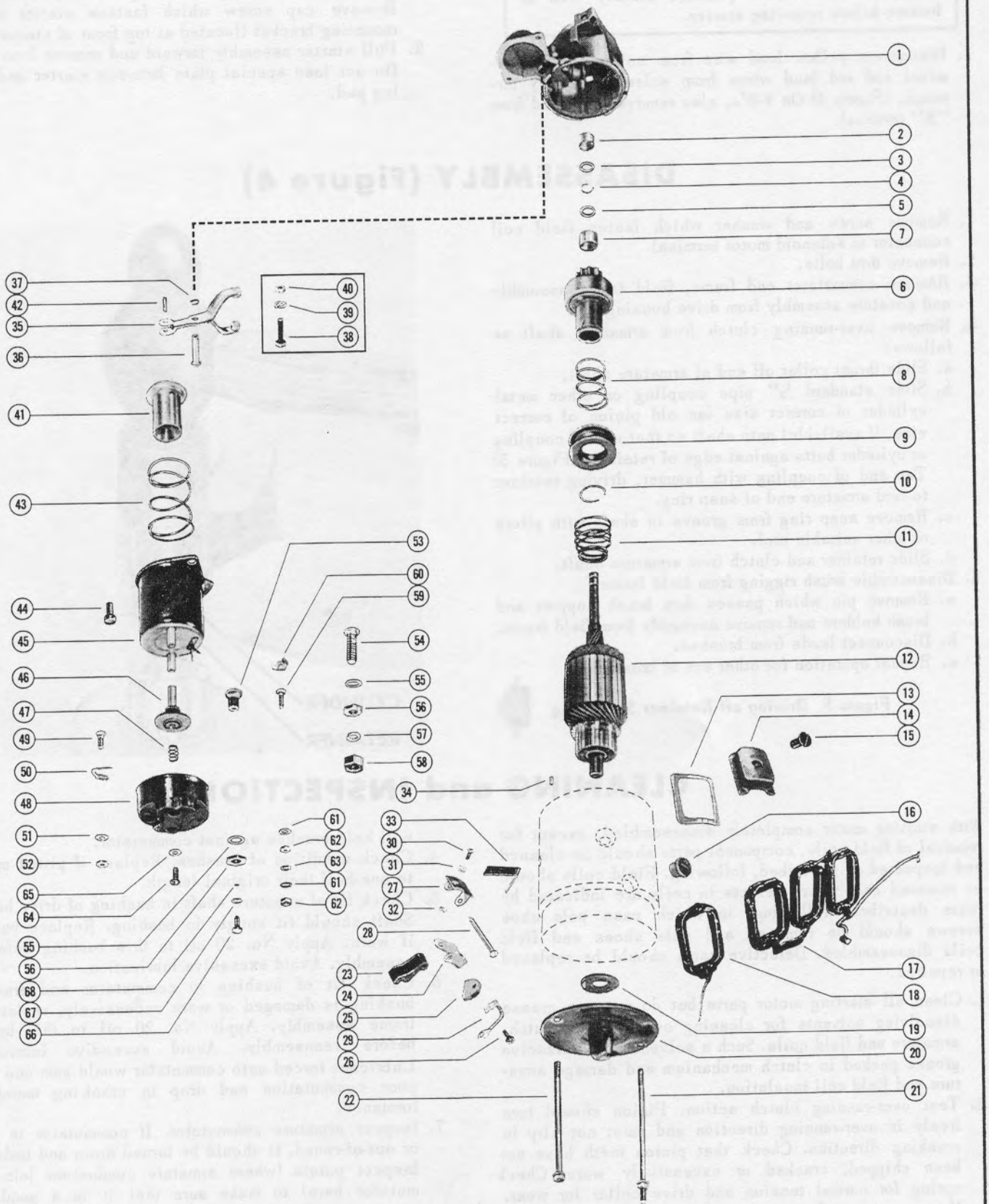

Figure 4. Typical Starting Motor - All Models, except MerCruiser 60, 80, 90 and 215E

REMOVAL (All Models, except Renault and Autolite)

CAUTION: Disconnect positive battery lead at battery before removing starter.

1. Disconnect yellow lead wire from solenoid "S" terminal and red lead wires from solenoid battery terminal. (Figure 4) On V-8's, also remove pink lead from "R" terminal.
2. Remove 2 starter pad mounting bolts and flat washer. Remove cap screw which fastens starter motor to mounting bracket (located at top front of starter motor.)
3. Pull starter assembly forward and remove from engine. Do not lose special plate between starter and mounting pad.

DISASSEMBLY (Figure 4)

1. Remove screw and washer which fasten field coil connector to solenoid motor terminal.
2. Remove thru bolts.
3. Remove commutator end frame, field frame assembly and armature assembly from drive housing.
4. Remove over-running clutch from armature shaft as follows:
   a. Slide thrust collar off end of armature shaft.
   b. Slide standard ½" pipe coupling or other metal cylinder of correct size (an old pinion of correct size, if available) onto shaft so that end of coupling or cylinder butts against edge of retainer. (Figure 5) Tap end of coupling with hammer, driving retainer toward armature end of snap ring.
   c. Remove snap ring from groove in shaft with pliers or other suitable tool.
   d. Slide retainer and clutch from armature shaft.
5. Disassemble brush rigging from field frame.
   a. Remove pin which passes thru brush support and brush holders and remove assembly from field frame.
   b. Disconnect leads from brushes.
   c. Repeat operation for other set of brushes.

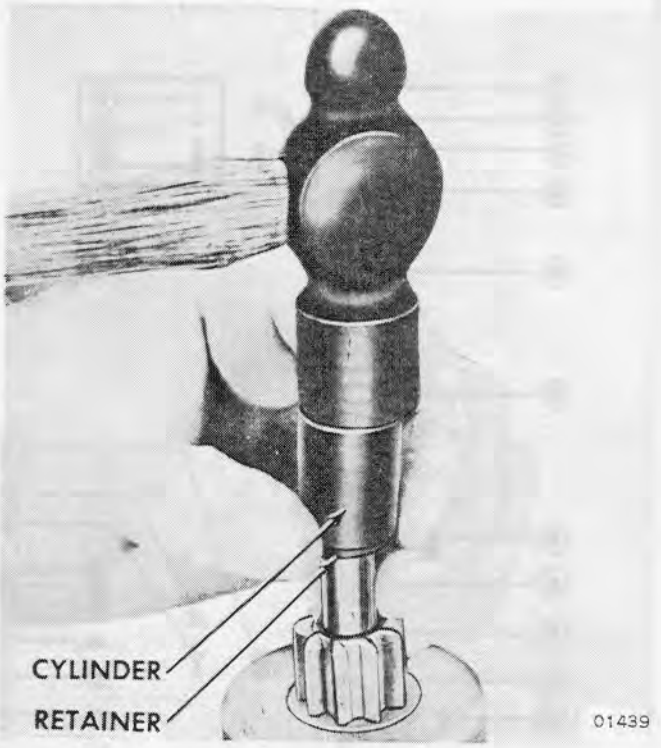

Figure 5. Driving off Retainer Snap Ring

CLEANING and INSPECTION

With starting motor completely disassembled, except for removal of field coils, component parts should be cleaned and inspected as described, following. Field coils should be removed only where defects in coils are indicated by tests described, following, in which case pole shoe screws should be removed and pole shoes and field coils disassembled. Defective parts should be replaced or repaired.

1. Clean all starting motor parts but do not use grease dissolving solvents for cleaning over-running clutch, armature and field coils. Such a solvent would dissolve grease packed in clutch mechanism and damage armature and field coil insulation.
2. Test over-running clutch action. Pinion should turn freely in over-running direction and must not slip in cranking direction. Check that pinion teeth have not been chipped, cracked or excessively worn. Check spring for normal tension and drive collar for wear. If necessary, replace spring or collar by forcing collar toward clutch and removing lock ring from end of tube.
3. Check that brush holders are not damaged or bent and will hold brushes against commutator.
4. Check condition of brushes. Replace if pitted or worn to one-half their original length.
5. Check fit of armature shaft in bushing of drive housing. Shaft should fit snugly in bushing. Replace bushing, if worn. Apply No. 20 oil to this bushing before reassembly. Avoid excessive lubrication.
6. Check fit of bushing in commutator end frame. If bushing is damaged or worn excessively, replace end frame assembly. Apply No. 20 oil to this bushing before reassembly. Avoid excessive lubrication. Lubricant forced onto commutator would gum and cause poor commutation and drop in cranking motor performance.
7. Inspect armature commutator. If commutator is rough or out-of-round, it should be turned down and undercut. Inspect points (where armature conductors join commutator bars) to make sure that it is a good, firm connection. Burned commutator bar usually is evidence of poor connection. See "Turning the Commutator", following.

COMPONENT CHECKS

ARMATURE

ARMATURE TEST FOR SHORTS

Check armature for short circuits by placing on growler and holding hack saw blade over armature core while armature is rotated. (Figure 6) If saw blade vibrates, armature is shorted. Recheck after cleaning between commutator bars. If saw blade still vibrates, replace armature.

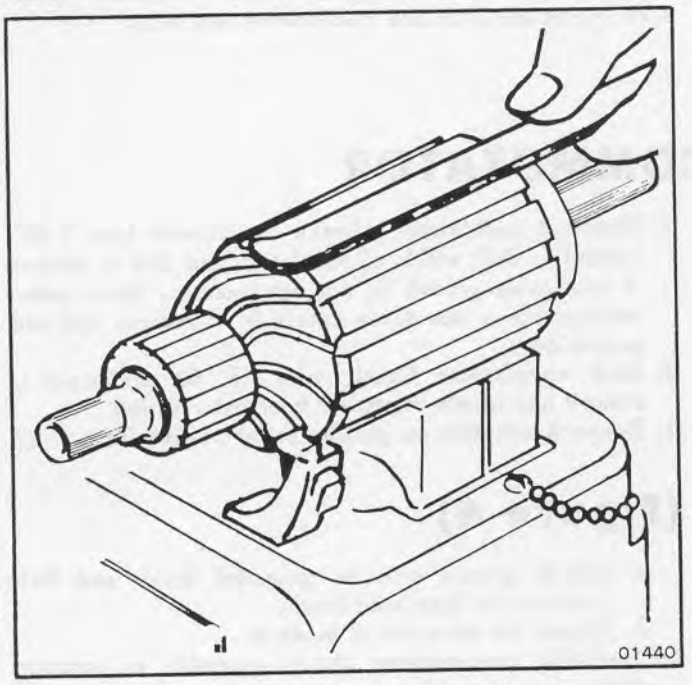

Figure 6. Armature Tests for Shorts

ARMATURE TEST FOR GROUND

1. With Magneto Analyzer selector switch set on Scale No. 3 (Continuity) (or using, VOA Tester [C-91-52751] on Rx1 scale), place one lead on armature core or shaft and other lead on commutator.

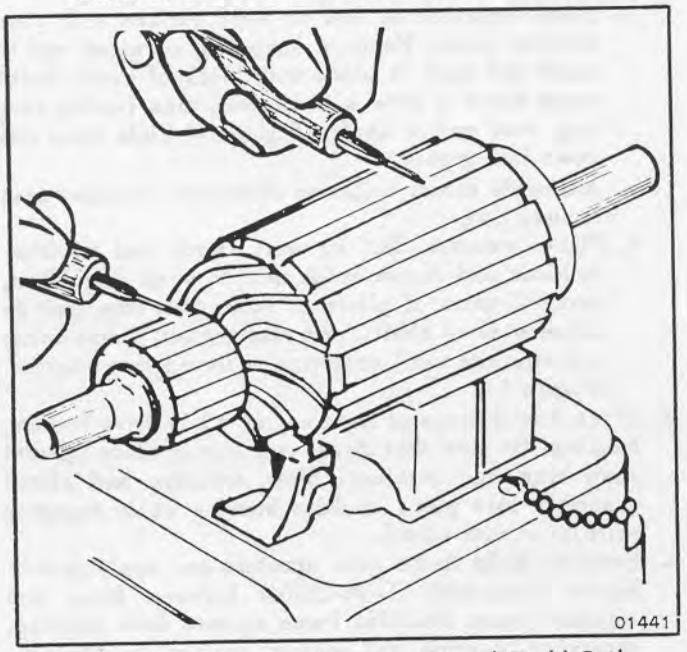

Figure 7. Armature Test for Ground Field Coil

2. If meter hand on Analyzer (or VOA Tester) moves to right, armature is grounded and must be replaced. (Figure 7)

FIELD COIL

FIELD COIL TEST FOR OPEN CIRCUIT

1. With Magneto Analyzer selector switch set on Scale No. 3 (Continuity) (or using VOA Tester on Rx1 scale), place one lead on each end of field coils.
2. If meter hand on Analyzer (or VOA Tester) does not move to right, field coils are open and must be replaced. (Figure 8)

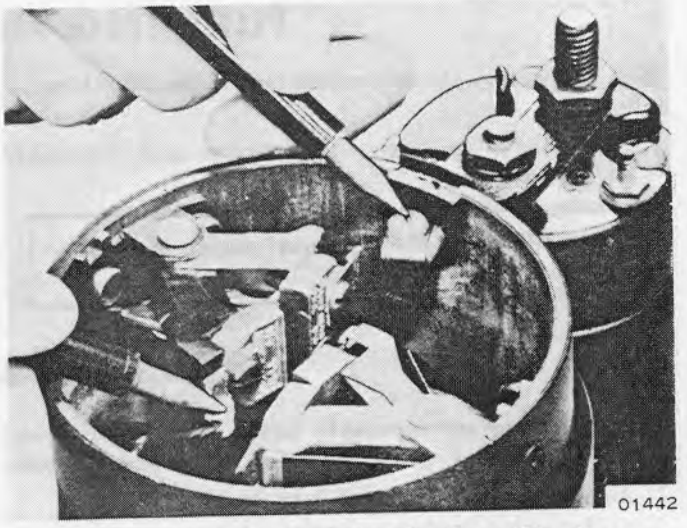

Figure 8. Field Coil Test for Open Circuit

FIELD COIL TEST FOR GROUND

1. With Magneto Analyzer selector switch set on Scale No. 3 (Continuity), or using VOA Tester on Rx1 scale, place one lead on field coil connector and other lead on field frame.
2. If meter hand moves to right, field coils are grounded and must be replaced. (Figure 9)

Figure 9. Field Coil Test for Ground

SUMMARY of STARTER CHECKS

Component	Connection	Reading	Result
Armature	1. Armature on growler. Hack saw blade over armature core.	Saw vibrates	Shorted
	2. Analyzer from armature core to commutator.	Low	Grounded

Component	Connection	Reading	Result
Field Coil	1. Analyzer to each end of field coils.	Low	Open
	2. Analyzer from field coil to field frame.	Low	Grounded

LOOSE ELECTRICAL CONNECTIONS

If open soldered connection of armature to commutator leads is found during inspection, resolder with rosin flux.

CAUTION: Never use acid flux on electrical connections.

BRUSH HOLDER REPLACEMENT

If brush holders are damaged, replace by special service units which are attached with screws and nuts.

TURNING the COMMUTATOR

When inspection shows commutator roughness, clean as follows:

1. Turn down commutator in a lathe until thoroughly cleaned.

CAUTION: Do not cut beyond section previously turned.

2. Undercut insulation between commutator bars 1/32" (.8mm) to full width of insulation and flat at bottom. A triangular groove is not satisfactory. After undercutting, clean out slots carefully to remove dirt and copper dust.
3. Sand commutator lightly with No. 00 sandpaper to remove any slight burrs left from undercutting.
4. Recheck armature on growler for short circuits.

REASSEMBLY (Figure 4)

After all parts are thoroughly tested and inspected and worn or damaged parts replaced, reassemble starter.

1. Assemble brush rigging to field frame.
   a. Assemble brushes to brush holders.
   b. Place flat washer over each support pin, then assemble insulated and grounded brush holders together with "V" spring and position as a unit on support pin. Push holders and spring to bottom of support and rotate spring to engage "V" in slot in support.
   c. Attach ground wire to grounded brush and field lead wire to insulated brush.
   d. Repeat for other set of brushes.
2. Assemble over-running clutch assembly to armature shaft.
   a. Lubricate drive end of armature shaft with No. 10 oil.
   b. Slide assist spring and clutch assembly onto armature shaft with pinion outward.
   c. Slide retainer onto shaft with cupped surface facing end of shaft (away from pinion).
   d. Stand armature on end on wood surface with commutator down. Position snap ring on upper end of shaft and hold in place with block of wood. Strike wood block a blow with hammer, thus forcing snap ring over end of shaft. (Figure 10) Slide snap ring down into groove.
   e. Assemble thrust collar on shaft with shoulder next to snap ring.
   f. Place armature flat on work bench and position retainer and thrust collar next to snap ring. Then, using 2 pairs of pliers at same time (one pair on either side of shaft), grip retainer and thrust collar and squeeze until snap ring is forced into retainer. (Figure 11)
3. Place 4 or 5 drops of light engine oil in drive housing bushing. Be sure that thrust collar is in place against snap ring and retainer. Slide armature and clutch assembly into place in drive housing while engaging shift lever with clutch.
4. Position field frame over armature and apply gasket Sealer Compound (C-92-28804) between frame and solenoid case. Position frame against drive housing, observing caution to prevent damage to brushes.

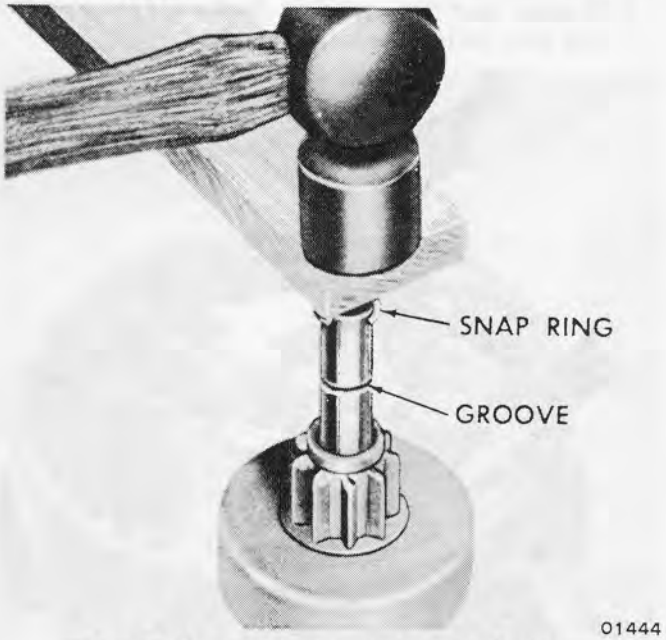

Figure 10. Forcing Snap Ring Over Shaft

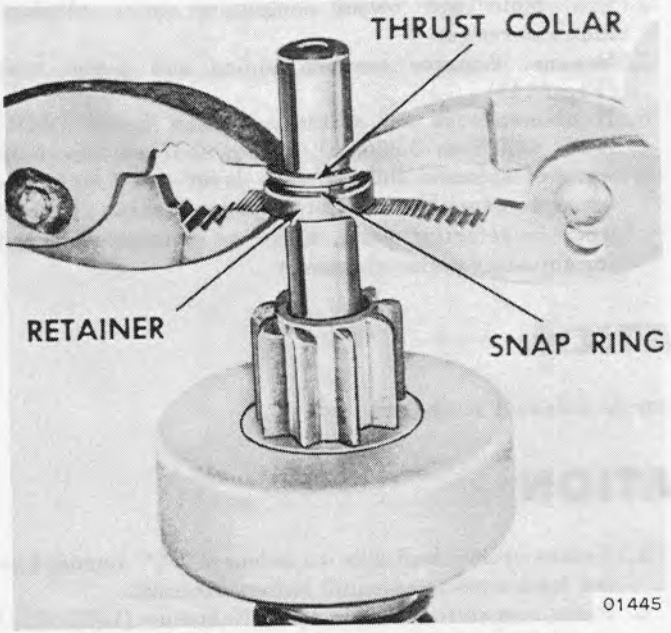

Figure 11. Forcing Snap Ring into Retainer

5. Place 4 to 5 drops of light engine oil in bushing in commutator end frame. Place leather brake washer on armature shaft and slide commutator end frame onto shaft.
6. Reconnect field coil connector to "motor" solenoid terminal.
7. After reassembly, a "no load" check of starting motor may be made if equipment is available. To check, connect starter motor in series with a fully-charged 12-volt battery, an ammeter capable of reading several hundred amperes and a variable resistance. Also connect a voltmeter, as illustrated, from motor terminal to motor frame. An RPM indicator is necessary to measure armature speed. (Figure 12) Obtain specified voltage by varying resistance unit. Then read current draw and armature speed and compare these readings with values listed below.

   Volts - 10.6
   Amperes - 49-76
   RPM - 6200-9400

8. If readings are not correct, refer to "Troubleshooting", preceding.

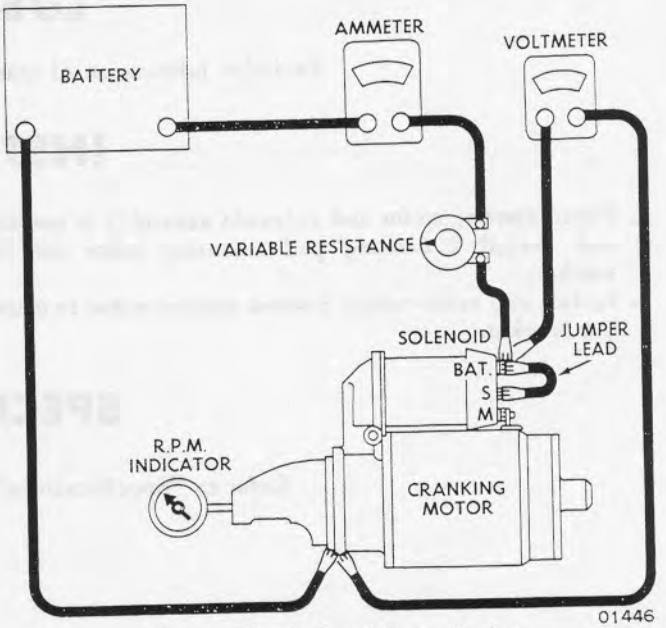

Figure 12. No Load Test Hookup

PINION CLEARANCE

Check pinion clearance after reassembly of motor to insure proper adjustment. Check pinion clearance as follows:

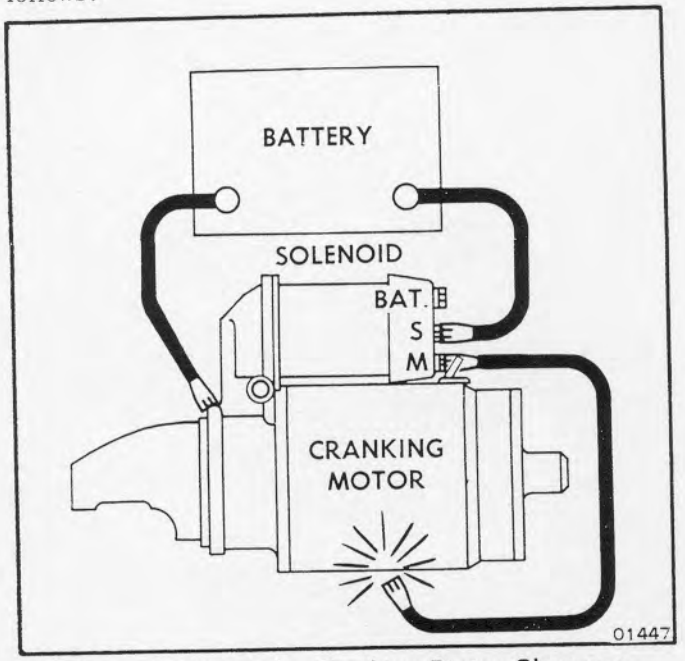

Figure 13. Circuit for Checking Pinion Clearance

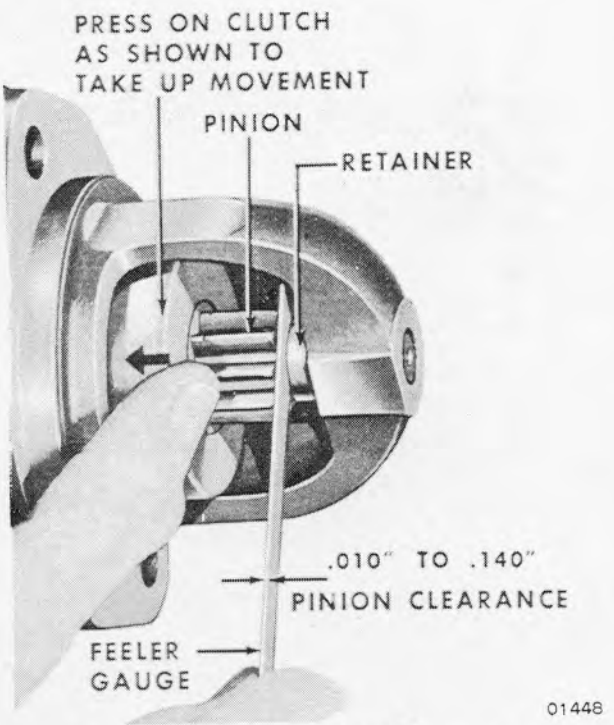

Figure 14. Checking Pinion Clearance

1. Disconnect motor field coil connector from solenoid motor terminal and insulate it carefully.
2. Connect 12-volt battery from solenoid switch terminal to solenoid frame. (Figure 13)
3. Momentarily flash a jumper lead from solenoid motor terminal to solenoid frame. This shifts pinion into cranking position where it will remain until battery is disconnected.
4. Push pinion back toward commutator end to eliminate slack movement.
5. Measure distance between pinion and pinion stop. (Figure 14)
6. If clearance is not within specified limits (.010"-.140") (.025mm 3.556mm), it may indicate excessive wear of solenoid linkage shift lever yoke buttons or improper assembly of shift lever mechanism. Replace worn or defective parts, since no provision is made for adjusting pinion clearance.

LUBRICATION

Periodic lubrication of starting motor or solenoid is not required.

INSTALLATION

1. Place starting motor and solenoid assembly in position and install 2 starting pad mounting bolts and flat washer.
2. Install cap screw which fastens starter motor to mounting bracket.
3. Fasten yellow lead wire to solenoid "S" terminal and red lead wires to solenoid battery terminal.
4. Paint connections with Liquid Neoprene (C-92-25711) to prevent corrosion.
5. Check operation of starter on engine.

SPECIFICATIONS

Refer to "Specifications" Section 8 for starter specifications.

STARTER MOTOR - "60" MARINE ENGINE

DESCRIPTION

The MerCruiser "60" starter is similar to the Delco-Remy starter, preceding. Only the differences will be discussed in this section.

PERIODIC INSPECTION and TROUBLESHOOTING

Periodic Inspection and Troubleshooting are the same as the Delco-Remy starter, preceding.

REMOVAL

CAUTION: Disconnect positive (+) battery lead at battery before starting removal.

1. Remove yellow lead wire from solenoid "S" terminal and red lead wires from solenoid battery terminal.
2. Remove 3 thru bolts and nuts which hold starter to flywheel housing. (Figure 1)
3. Pull starter assembly forward and remove from engine.

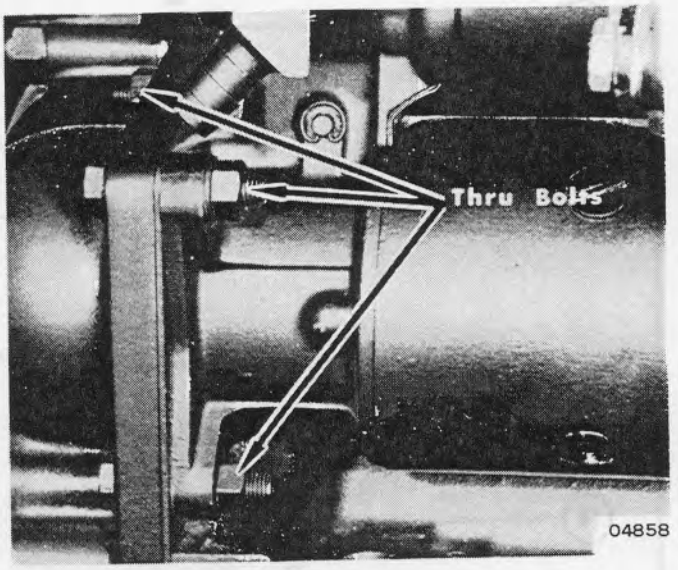

Figure 1. Starter Bolt Location

DISASSEMBLY (Figure 2)

1. Remove nut and washer which fasten field coil connector to solenoid motor terminal.
2. Remove thru bolt, nuts and washers.
3. Remove 2 small nuts and washers from solenoid thru bolts.
4. Remove shift lever retaining ring and shaft.
5. Remove solenoid and shift lever assembly.
6. Remove front housing.
7. Remove field brush from brush clip and remove armature.
8. Remove roll pin, stop collar and drive assembly from drive assembly end.
9. Remove screw and brush housing assembly from commutator end.
10. Remove 4 screws from housing and remove field coil assembly.
11. To disassemble solenoid, loosen shift lever bolt and remove shift lever assembly.

CLEANING, INSPECTION and COMPONENT CHECK

Cleaning, Inspection and Component Checks are the same as Delco-Remy starter, preceding.

ADJUSTMENT

1. If starter motor requires disassembly, adjust pinion in released position and connection between plunger and fork before reassembling.
2. Adjusting pinion in released position
   a. Make sure that end plate on commutator side contacts frame and armature, then position Gauge C-91-39123. (Figure 3)

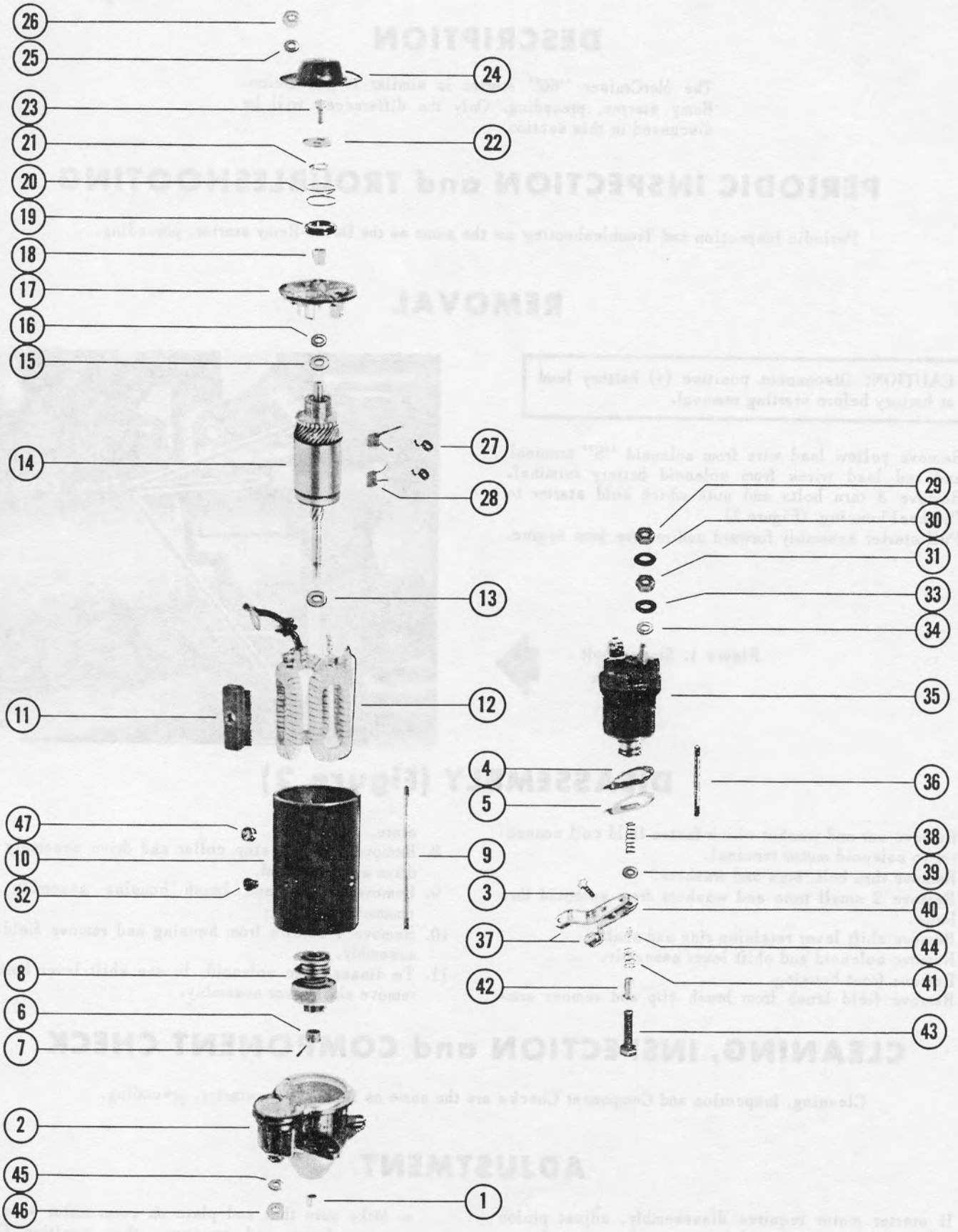

Figure 2. Starter Motor Exploded View – MerCruiser "60"

1 Bushing, end housing
2 Housing, end
3 Pin, arm to solenoid
4 Gasket, solenoid
5 Plate, solenoid
6 Nut, drive assembly to armature
7 Pin, armature nut
8 Drive Assembly
9 Bolt, thru, starter housing
10 Housing, starter
11 Retainer, field coil
12 Field Coil
13 Washer, retaining armature
14 Armature
15 Washer, plain
16 Washer, fiber
17 Brush holder end plate
18 Bushing, end plate
19 Retainer, spring
20 Spring
21 Washer
22 Plate
23 Bolt
24 Cover, end
25 Washer, lock
26 Nut, thru bolt
27 Clip, brush
28 Brush, negative and positive
29 Nut, terminal
30 Washer, lock, terminal
31 Nut, terminal
32 Bolt, field coil
33 Washer, lock, terminal
34 Washer, plain, terminal
35 Solenoid, starter
36 Bolt, thru, solenoid
37 Pad, solenoid arm
38 Spring
39 Washer
40 Arm, solenoid
41 Spring
42 Bolt, hollow
43 Bolt, solenoid arm
44 Pin, retaining
45 Washer, solenoid thru bolt
46 Nut, solenoid thru bolt
47 Grommet, starter motor

(Legend for Figure 2 - Starter Motor Exploded View)

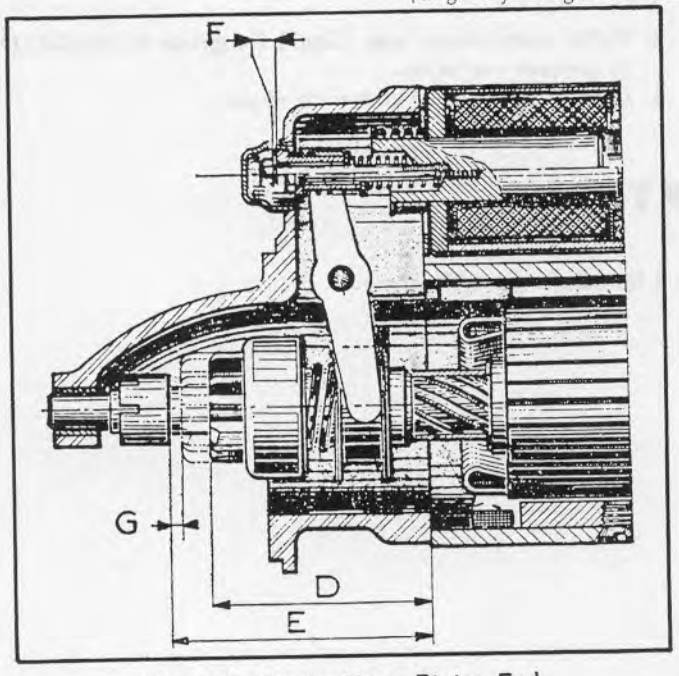

Figure 3. Starter Motor Pinion End

b. Screw in front stop and bring it into contact with outside edge of gauge which represents dimension "E" (foremost position of pinion). (Figure 4)
c. After adjustment of stop, insert a new roll pin.

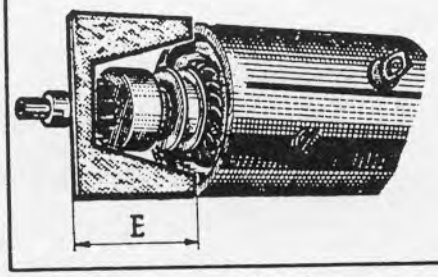

Figure 4. Dimension "E"

3. Adjusting connection between solenoid plunger and link
   a. Mount "switch-end plate" assembly on armature.
   b. Push control rod fully in and check clearance "G" (.00197" to .0591") (.050mm-1.501mm) between pinion and front stop. (Figure 5)
   c. Allow assembly to return and tighten or loosen sleeve ("1" in Figure 6) with a socket to obtain correct clearance "G" with "F" dimension as small as possible.
   d. Check that starter drive pinion bears on rear stop when in released position.

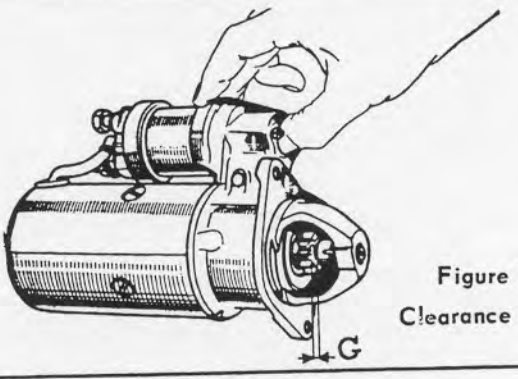

Figure 5. Clearance "G"

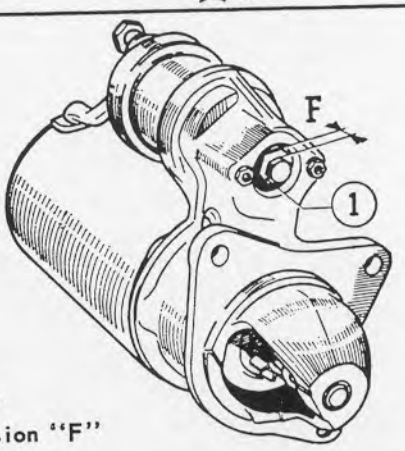

Figure 6. Dimension "F"

TURNING the COMMUTATOR

Follow same procedure as outlined in Delco-Remy starter, preceding.

REASSEMBLY

Refer to Figure 2 and reassemble in reverse order of disassembly.

LUBRICATION

Periodic lubrication of starting motor or solenoid is not required.

INSTALLATION

1. Place starting motor and solenoid assembly in position on engine and install 3 mounting bolts and nuts.
2. Fasten yellow lead wire to solenoid "S" terminal and red lead wires to solenoid battery terminal.
3. Paint connections with Liquid Neoprene (C-92-25711) to prevent corrosion.
4. Check operation of starter on engine.

SPECIFICATIONS

Refer to "Specifications" Section 8 for starter specifications.

STARTER MOTOR - "80" MARINE ENGINE

DESCRIPTION

The MerCruiser "80" starter is similar to the Delco-Remy starter, preceding. Only the differences will be discussed in this section.

NOTE: MerCruiser 80 Stern Drives (Serial No. 2332196 and up) are equipped with MerCruiser 90 starter motors. Refer to appropriate repair procedure.

PERIODIC INSPECTION and TROUBLESHOOTING

Periodic Inspection and Troubleshooting are the same as the Delco-Remy starter, preceding.

REMOVAL

CAUTION: Disconnect positive (+) lead at battery before starting removal.

1. Remove yellow lead wire from solenoid "S" terminal and red lead wires from solenoid battery terminal.
2. Remove 3 thru bolts and nuts which hold starter to flywheel housing.
3. Pull starter assembly forward and remove from engine. (Figure 1)

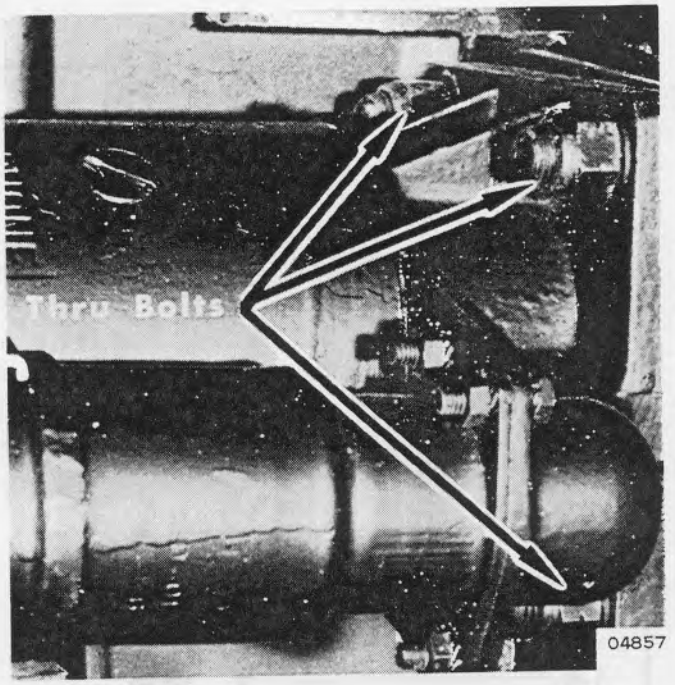

Figure 1. Starter Bolt Location

DISASSEMBLY

1. Remove 2 nuts and lockwashers and remove commutator end plate.
2. Remove nut on brush cover band and remove band.
3. Remove 4 bolts, nuts and lockwashers from solenoid to drive housing.
4. Remove retaining ring and shift lever shafts.
5. Remove solenoid.
6. Remove brush.
7. Remove drive end housing and shift lever.
8. While holding clutch, remove hex head bolt from commutator end and remove spring and plates.
9. Remove commutator brush assembly.
10. Remove armature.
11. Remove stop by pressing stop toward armature and remove snap rings and stop.
12. Remove drive assembly.
13. To remove field coil assembly, remove 4 screws and remove field coil.

CLEANING, INSPECTION and COMPONENT CHECKS

Cleaning, Inspection and Component Checks are the same as the Delco-Remy starter, preceding.

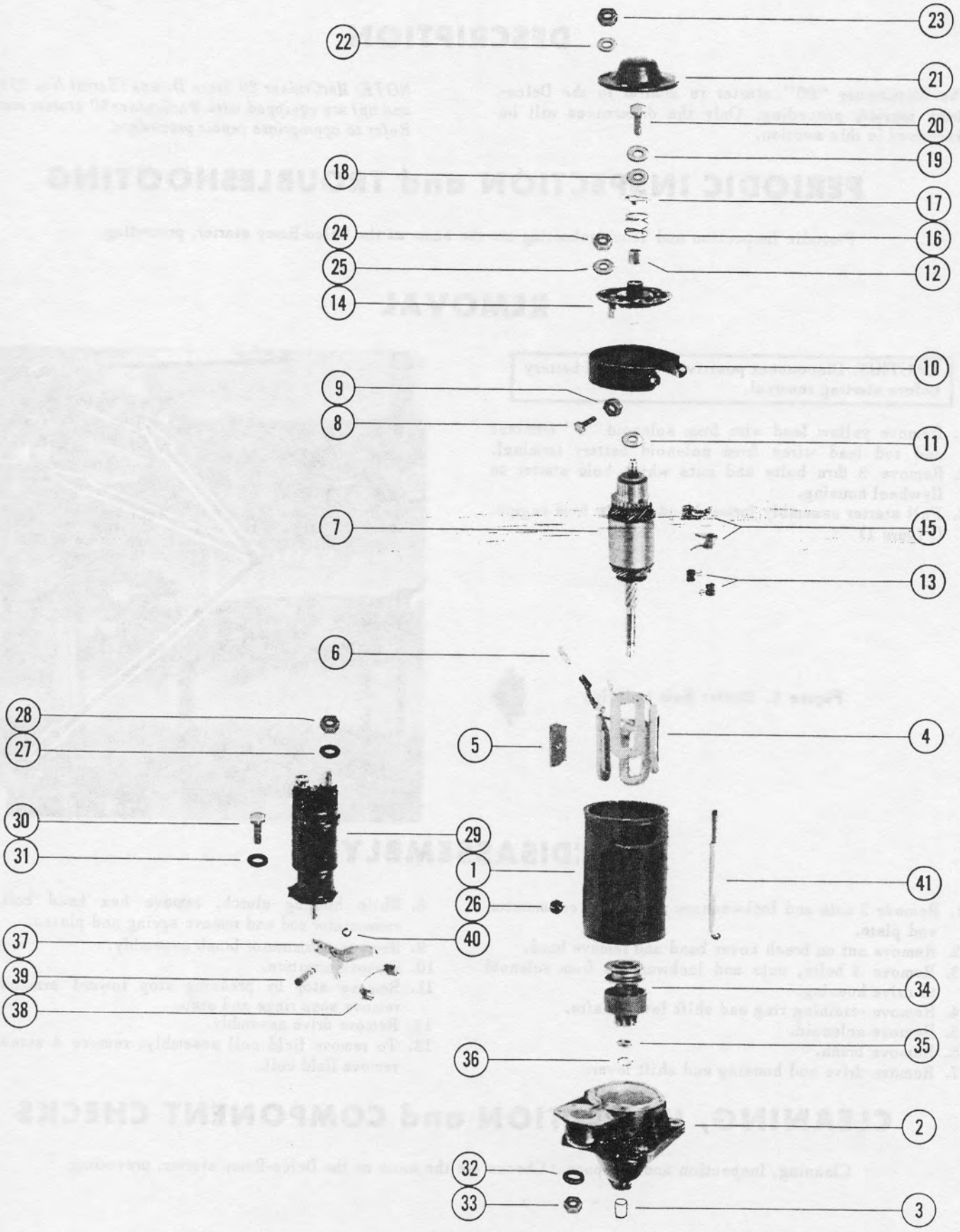

Figure 2. Starter Motor Exploded View – MerCruiser "80"

1 Housing, starter	22 Washer, plain
2 Housing, end	23 Nut
3 Bushing, end housing	24 Nut
4 Field Coil	25 Washer
5 Retainer, field coil	26 Screw, field coil
6 Terminal, field coil	27 Washer, lock, terminal
7 Armature	28 Nut, terminal
8 Bolt, motor band	29 Solenoid
9 Nut, motor band	30 Bolt, solenoid
10 Band, motor	31 Washer, lock , solenoid
11 Washer	32 Washer, lock , solenoid
12 Bushing, brush plate	33 Nut, solenoid
13 Clip, brush	34 Drive Assembly
14 Brush Plate	35 Retainer, clutch drive
15 Brush, negative and positive	36 Split Ring
16 Spring	37 Arm, solenoid
17 Retainer, spring	38 Insert, solenoid arm
18 Washer	39 Pin, solenoid arm
19 Washer	40 Retainer, pin
20 Bolt	41 Bolt thru
21 Cover	

(Legend for Figure 2 - Starter Motor Exploded View)

ADJUSTMENT

Adjust connection between core and fork.

1. Connect battery to solenoid as shown in Figure 3. Pinion moves to forward position. Field coil (Item 1) terminal should not be connected.

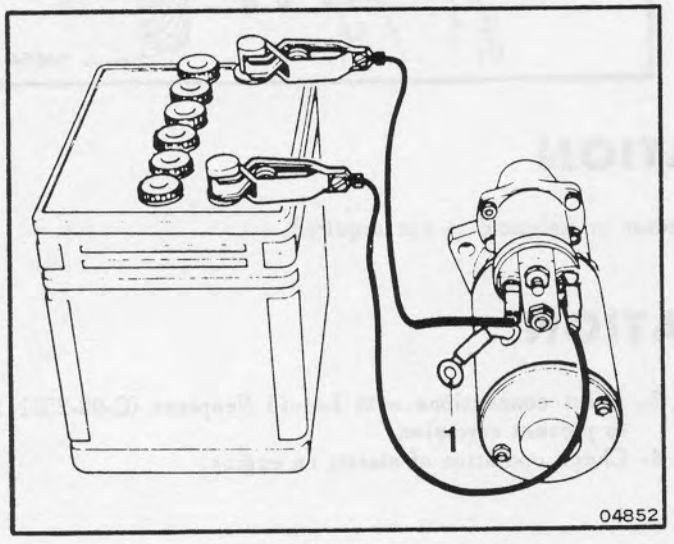

Figure 3. Clevis Adjustment Hookup

2. Clearance "H" of .020" to .099" should remain between the pinion (Item 2) and the stop (Item 3). (Figure 4)

3. If clearance is not correct, remove switch and screw clevis (Item 4) in or out to obtain correct clearance. (Figure 5)

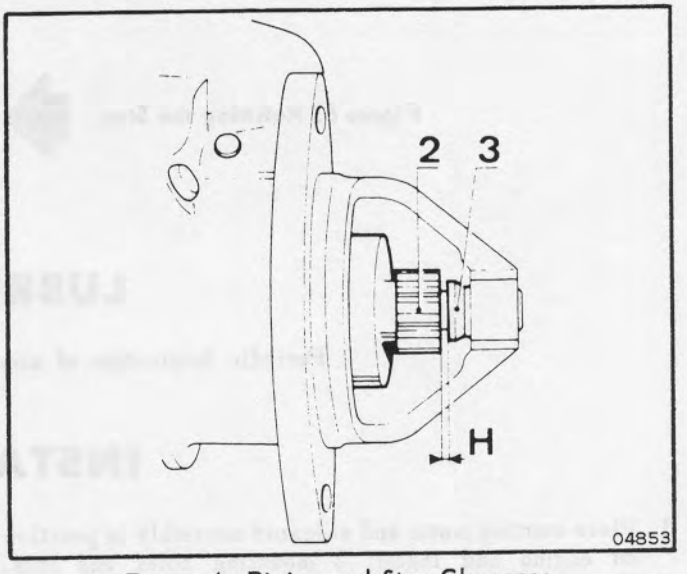

Figure 4. Pinion and Stop Clearance

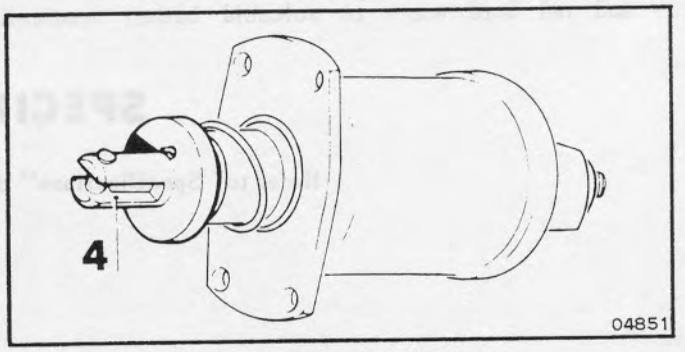

Figure 5. Clevis Adjustment

TURNING the COMMUTATOR

Follow same procedure as outlined in Delco-Remy starter, preceding.

REASSEMBLY

When reassembling, always fit a new front stop (B-23-46651) on armature shaft as follows:

1. Cover retaining snap rings with the stop.

2. Pean down end of the stop in 4 places to trap snap ring. (Figure 6)

3. Reassemble in reverse order of disassembly. (Figure 2)

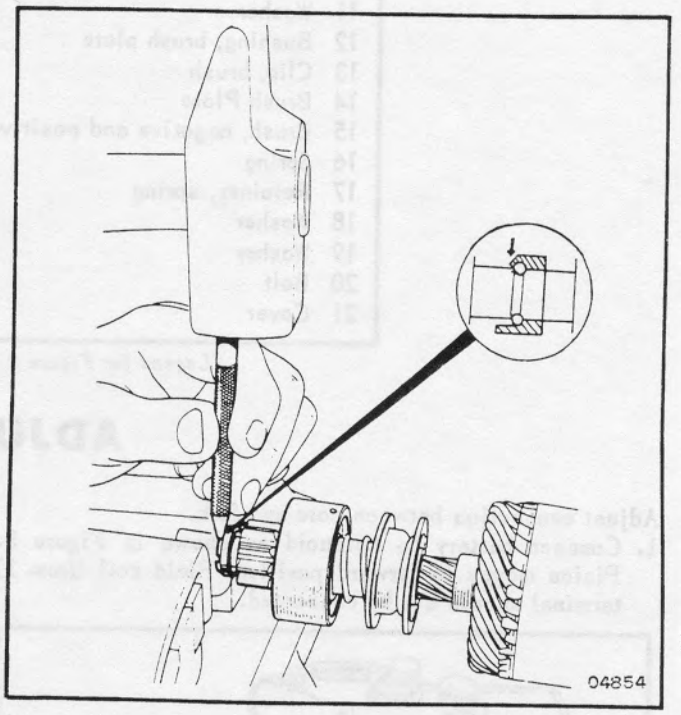

Figure 6. Refitting the Stop

LUBRICATION

Periodic lubrication of starting motor or solenoid is not required.

INSTALLATION

1. Place starting motor and solenoid assembly in position on engine and install 3 mounting bolts and nuts.
2. Fasten yellow lead wire to solenoid "S" terminal and red lead wires to solenoid battery terminal.
3. Paint connections with Liquid Neoprene (C-92-25711) to prevent corrosion.
4. Check operation of starter on engine.

SPECIFICATIONS

Refer to "Specifications" Section 8 for starter specifications.

STARTER MOTOR - "90" MARINE ENGINE

DESCRIPTION

The MerCruiser "90" starter is similar to Delco-Remy starter, preceding. Differences only will be discussed in this section.

PERIODIC INSPECTION and TROUBLESHOOTING

Periodic Inspection and Troubleshooting are same as Delco-Remy starter, preceding.

REMOVAL

CAUTION: Disconnect positive (+) lead at battery before starting removal.

1. Remove yellow lead wire from solenoid "S" terminal and red lead wires from solenoid battery terminal.
2. Remove 3 thru bolts and nuts which hold starter to flywheel housing.
3. Pull starter assembly forward and remove from engine. (Figure 1)

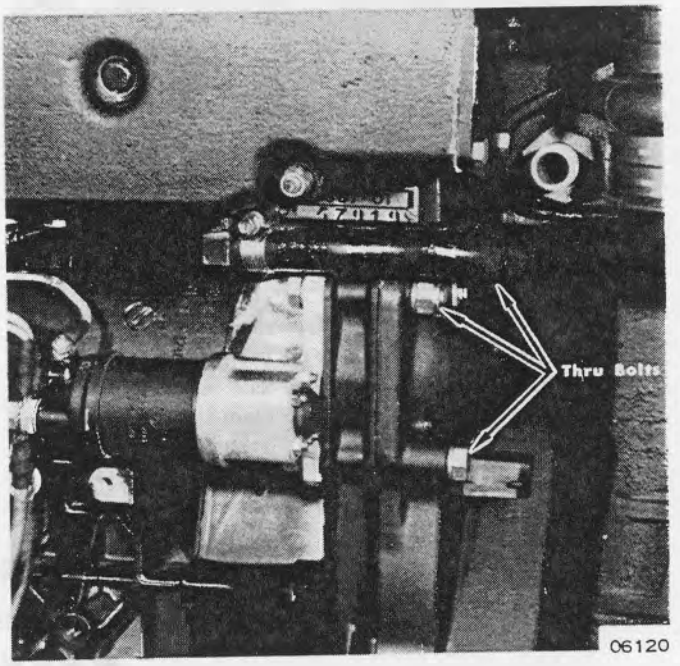

Figure 1. Starter Bolt Location

DISASSEMBLY

1. Remove field wire from solenoid.
2. Remove 2 nuts and lockwashers and remove housing assembly from armature and solenoid assembly.
3. Remove fiber washer, steel washer and wave washer from commutator end of armature.
4. Remove 4 nuts and lockwashers from solenoid to drive housing.
5. Remove retaining ring and shift lever shaft.
6. Pull armature and solenoid out of end housing. (Figure 2) Solenoid and armature will separate.
7. To remove shifting fork, screw adjusting slot on solenoid and remove nylon keeper.
8. Remove pinion stop by pressing stop toward armature and removing snap ring and stop.
9. Remove drive assembly and plate.
10. Remove nut on brush cover band and remove band and paper.
11. Remove brushes from brush holders and remove brush assembly.
12. To remove field coil assembly, remove 4 screws and field coil

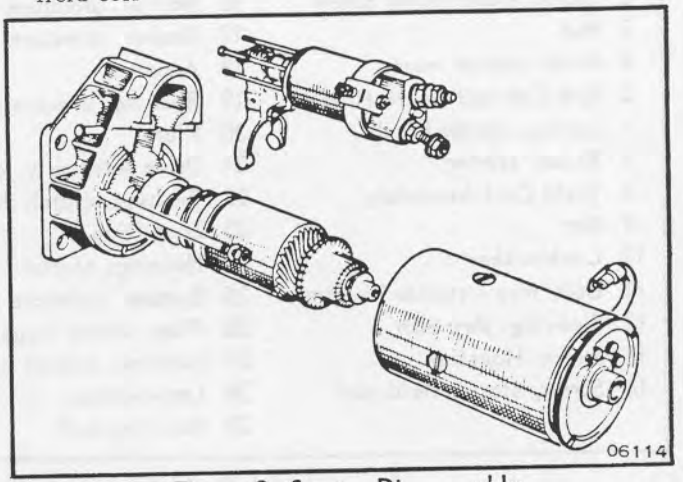

Figure 2. Starter Disassembly

CLEANING, INSPECTION and COMPONENT CHECKS

Cleaning, Inspection and Component Checks are same as Delco-Remy starter, preceding.

ADJUSTMENT

ADJUSTING CONNECTION BETWEEN CORE and FORK

1. Connect battery to solenoid as shown in Figure 3. Pinion moves to forward position. Do not connect field coil terminal.

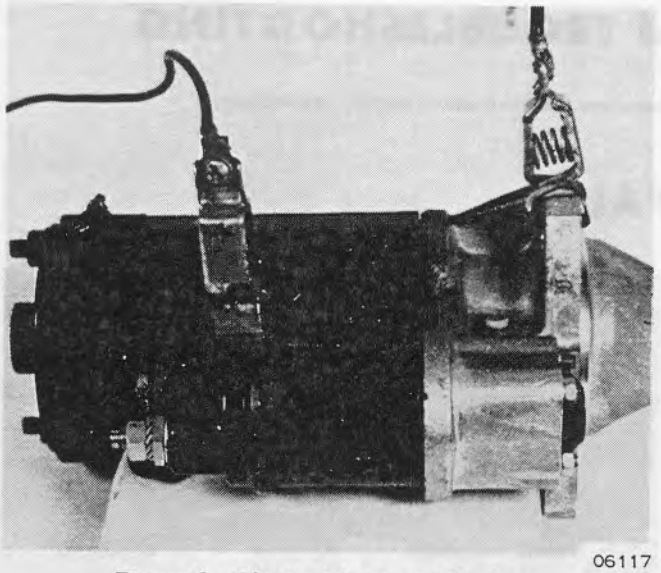

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Figure 3. Clevis Adjustment Hookup

2. Clearance of .020" to .099" (.51mm to 2.51mm) should remain between pinion and stop. If clearance is incorrect, remove rubber solenoid plug and screw clevis in or out for correct clearance. (Figure 5)

Figure 5. Clevis Adjustment ⟶

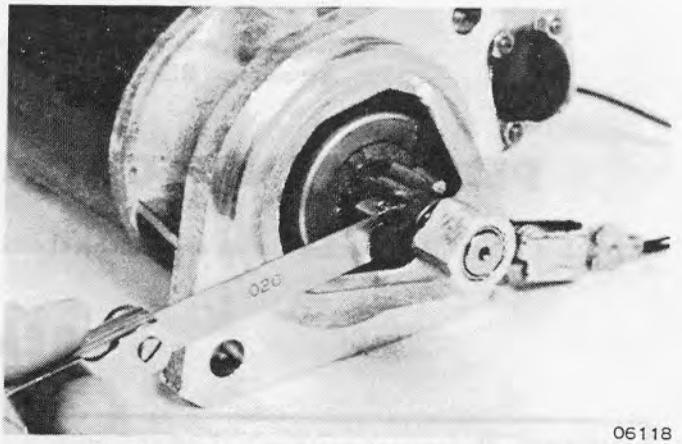

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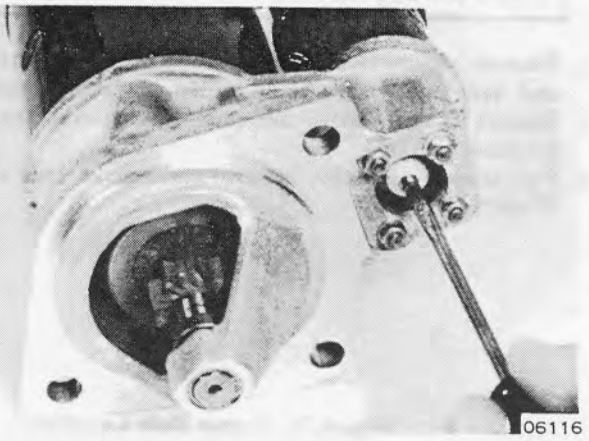
Figure 4. Pinion and Stop Clearance



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TURNING the COMMUTATOR

Follow same procedure as outlined in Delco-Remy starter, preceding.

REASSEMBLY

1. Cover retaining stop ring with stop. 2. Reassemble in reverse order of disassembly. (Figure 6)

1 Bushing, end cover	15 Washer, armature fiber	30 "D" Ring
2 Starter Motor Band Screw	16 Washer, armature wave	31 Arm, starter solenoid
3 Nut	17 Washer, armature fiber	32 Pin, solenoid arm to starter housing
4 Band, starter motor	18 Armature	33 Insert, starter solenoid arm
5 End Cap and Brush Holder	19 Bushing, armature shaft	34 Nut, starter solenoid
6 Spring, starter brush	20 Plate	35 Lockwasher, starter solenoid
7 Brush, starter	21 Drive Assembly, clutch	36 Solenoid End Cap
8 Field Coil Assembly	22 Bushing, clutch drive retaining	37 Starter Solenoid, starter housing
9 Nut	23 Snap Ring	38 Washer
10 Lockwasher	24 Housing, starter	39 Nut
11 Bolt, thru - starter housing	25 Bumper, solenoid to starter housing	40 Washer, solenoid to housing
12 Sleeving, thru bolt	26 Plug, starter housing	41 Nut, solenoid to housing
13 Starter Housing	27 Bushing, starter housing	42 Nut, starter solenoid
14 Screw, starter field coil	28 Lock washer	43 Lockwasher, starter solenoid
	29 Nut, thru bolt	

(Legend for Figure 6 - Starter Motor Exploded View)

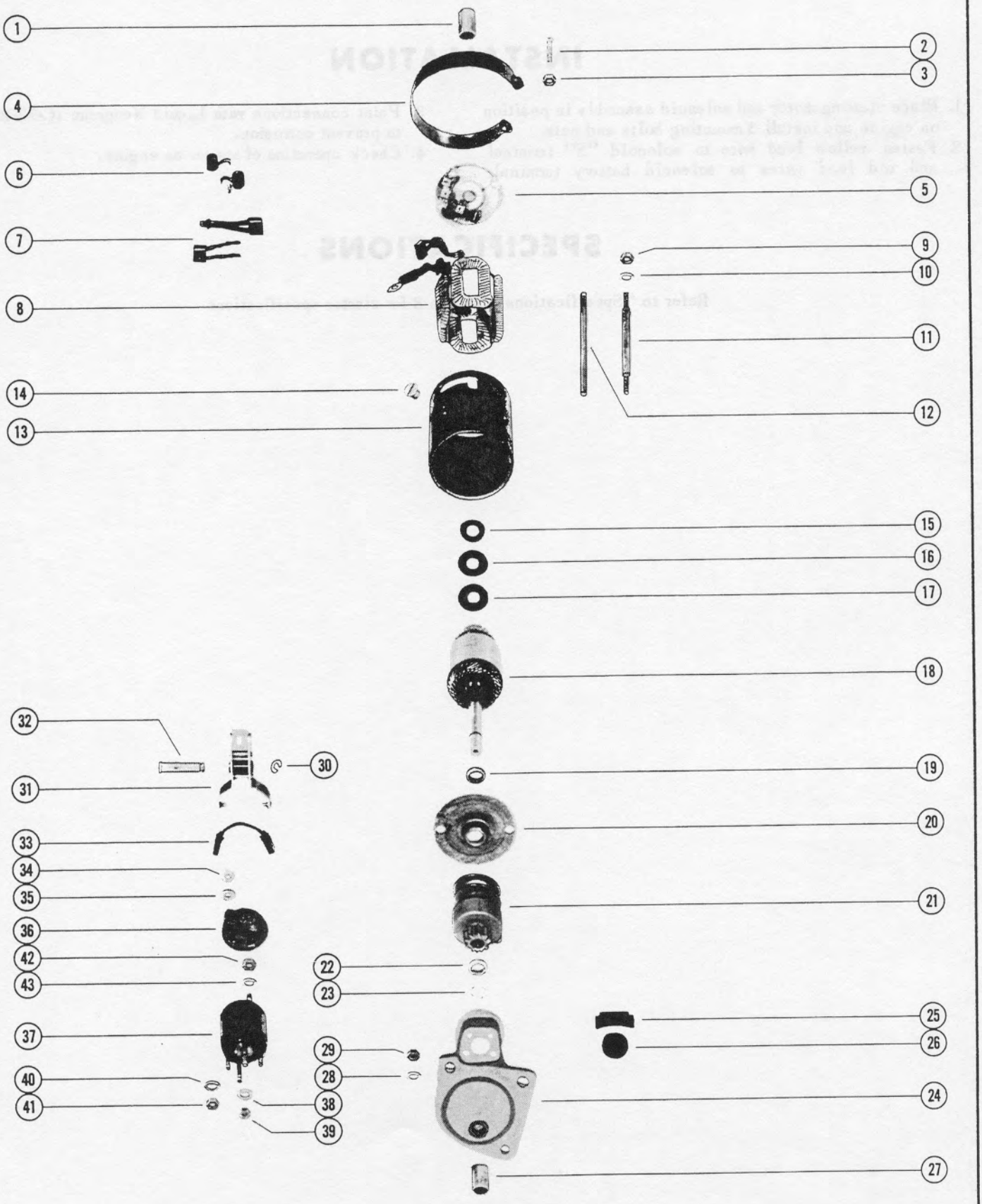

Figure 6. MerCruiser "90" Starter Motor Exploded View

LUBRICATION

Periodic lubrication of starting motor or solenoid is not required.

INSTALLATION

1. Place starting motor and solenoid assembly in position on engine and install 3 mounting bolts and nuts.
2. Fasten yellow lead wire to solenoid "S" terminal and red lead wires to solenoid battery terminal.
3. Paint connections with Liquid Neoprene (C-92-25711) to prevent corrosion.
4. Check operation of starter on engine.

SPECIFICATIONS

Refer to "Specifications" Section 8 for starter specifications.

STARTER MOTOR - AUTOLITE

DESCRIPTION

The starter utilizes on integral positive-engagement drive. When the starter is first connected to the battery, current flows through the grounded field coil, actuating a movable pole shoe. The pole shoe is attached to the starter drive plunger lever and, thus, the drive is forced into engagement with the flywheel.

When the movable pole shoe is fully seated, it opens the field coil grounding contacts, and the starter then is in normal operation. A holding coil is used to maintain the movalbe pole shoe in the fully seated position during the time that the starter is turning the engine.

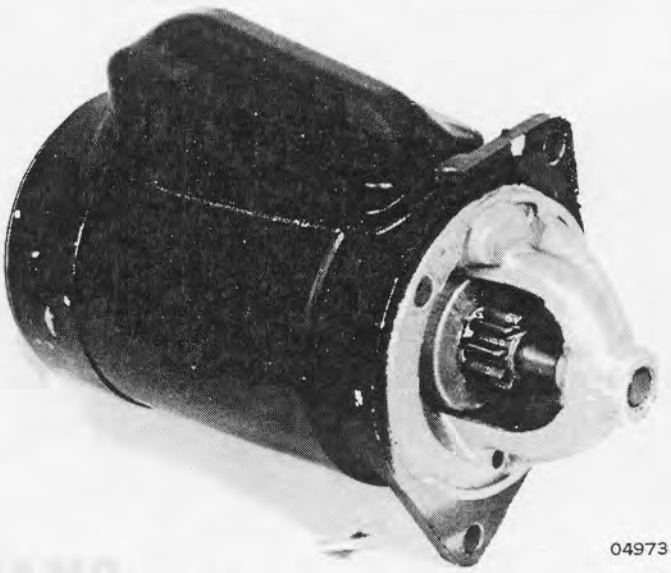

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Figure 1. Positive Engagement Starters

PERIODIC INSPECTION

Cranking motor is completely enclosed in drive housing to prevent entry of moisture and dirt. However, as an aid to preventive maintenance, periodic inspection is required as follows:

1. Inspect terminals for corrosion and loose connections.
2. Inspect wiring for frayed and worn insulation.
3. Check mounting bolts for tightness.

TROUBLESHOOTING

Starting motor specifications cannot be checked while starting motor is mounted on engine. Starting system, however, can be checked for excessive resistance in starting circuit which could cause battery to run down.

CRANKING CIRCUIT TEST

Excessive resistance in starter circuit can be determined from results of this test. Make test connections as shown in Figure 2. Crank engine with ignition "OFF" by disconnecting and grounding high tension lead from ignition coil and by connecting a jumper from battery terminal of starter relay to "S" terminal of relay.

Voltage drop in circuit will be indicated by voltmeter (0 to 2 volt range). Maximum allowable voltage drop should be:

1. With voltmeter negative (-) lead connected to starter terminal, and positive (+) lead connected to battery positive terminal (Figure 2), connection (1) 0.5 volt.
2. With voltmeter negative (-) lead connected to battery terminal of starter relay, and positive (+) lead connected to positive terminal battery (Figure 2), connection (2) 0.1 volt.
3. With voltmeter negative (-) lead connected to starter terminal of starter relay, and positive (+) lead connected to positive terminal of battery (Figure 2), connection (3) 0.3 volt.
4. With voltmeter negative (-) lead connected to negative terminal of battery, and positive (+) lead connected to engine ground (Figure 2), connection (4) 0.1 volt.

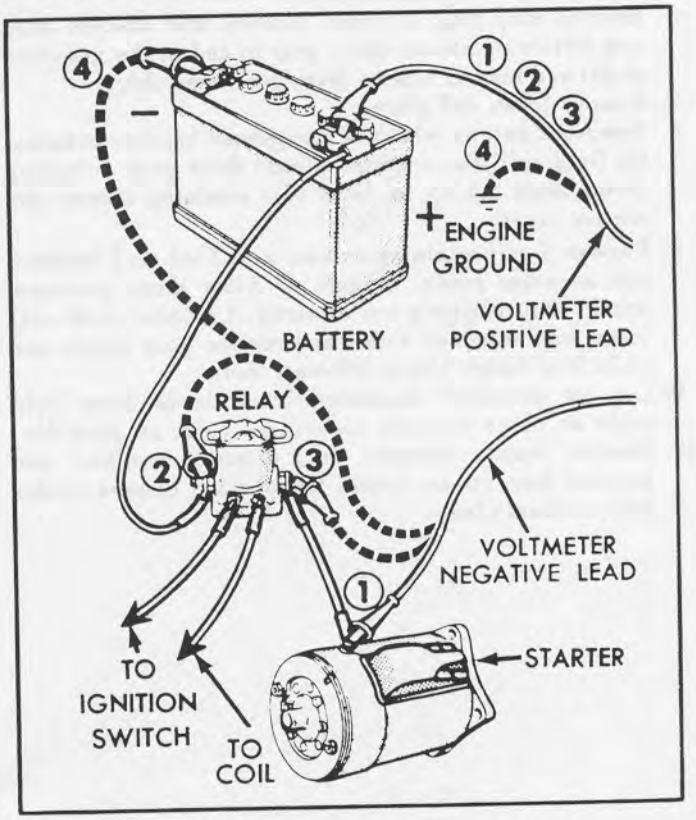

Figure 2. Starter Cranking Circuit Tests

REMOVAL

1. Disconnect red starter cable at starter terminal.
2. Remove starter mounting bolts. (Figure 3)
3. Pull starter forward and remove from engine.

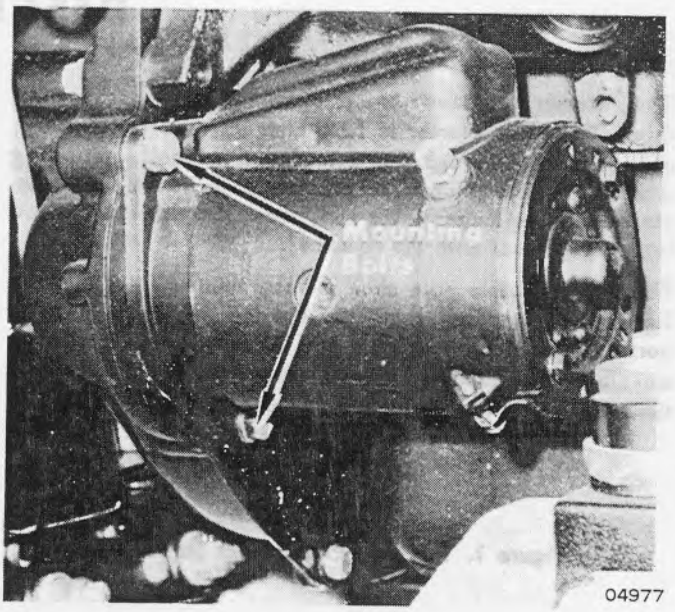

Figure 3. Starter Mounting

DISASSEMBLY

1. Loosen brush cover band retaining screw and remove brush cover band and starter drive plunger lever cover. Observe lead positions for assembly, then remove commutator brushes from brush holders.
2. Remove the thru bolts, starter drive end housing, and starter drive plunger lever return spring.
3. Remove pivot pin (retaining starter gear plunger lever) and remove lever and armature.
4. Remove stop ring retainer. Remove and discard stop ring (retaining starter drive gear to end of the armature shaft) and remove starter drive gear assembly.
5. Remove brush end plate.
6. Remove 2 screws which secure ground brushes to frame.
7. On field coil that operates starter drive gear actuating lever, bend tab up on field coil retaining sleeve and remove sleeve.
8. Remove 3 coil retaining screws with Ford tool 10044-A and an arbor press. (Figure 4) Arbor press prevents wrench from slipping out of screw. Unsolder field coil leads from terminal screw and remove pole shoes and coils from frame. Use a 300-watt iron.
9. Cut (or unsolder) insulated brush leads from field coils as close to field connection point as possible.
10. Remove starter terminal nut, washer, insulator and terminal from starter frame. Remove any excess solder from terminal slot.

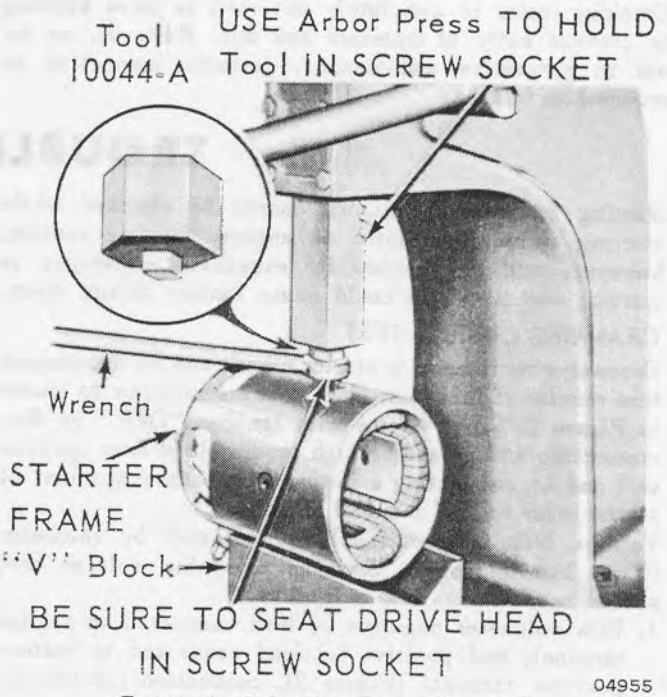

Figure 4. Pole Shoe Screw Removal

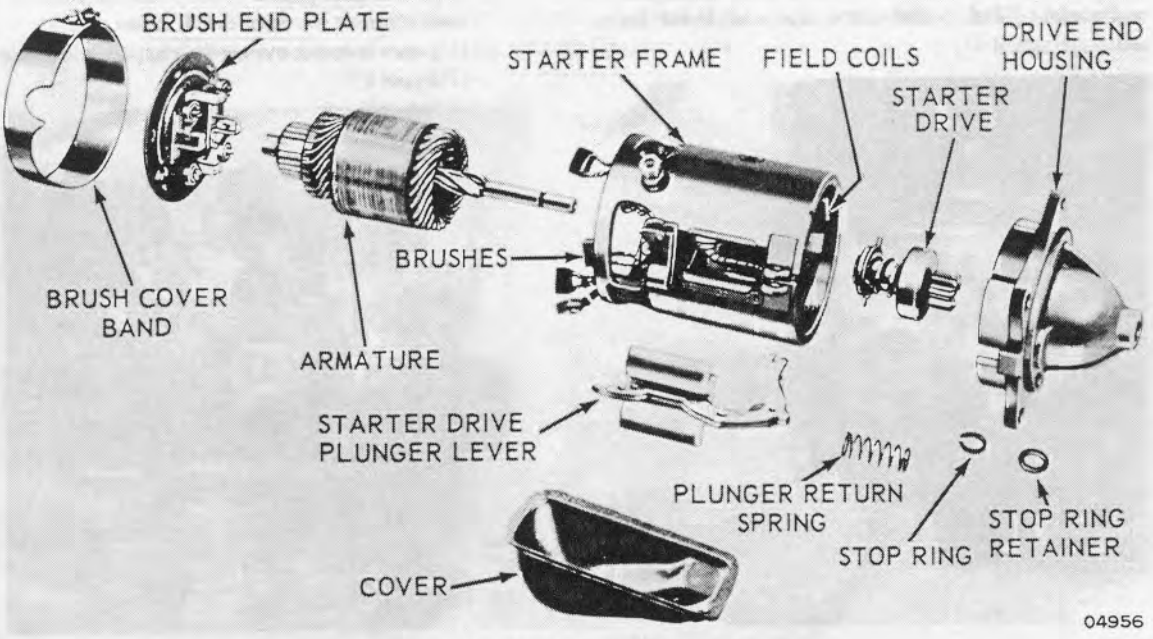

Figure 5. Starter - Exploded View

COMPONENT CHECKS

ARMATURE

ARMATURE TEST FOR SHORTS

Check armature for short circuits by placing on growler and holding hack saw blade over armature core while armature is rotated. (Figure 6) If saw blade vibrates, armature is shorted. Recheck after cleaning between commutator bars. If saw blade still vibrates, replace armature.

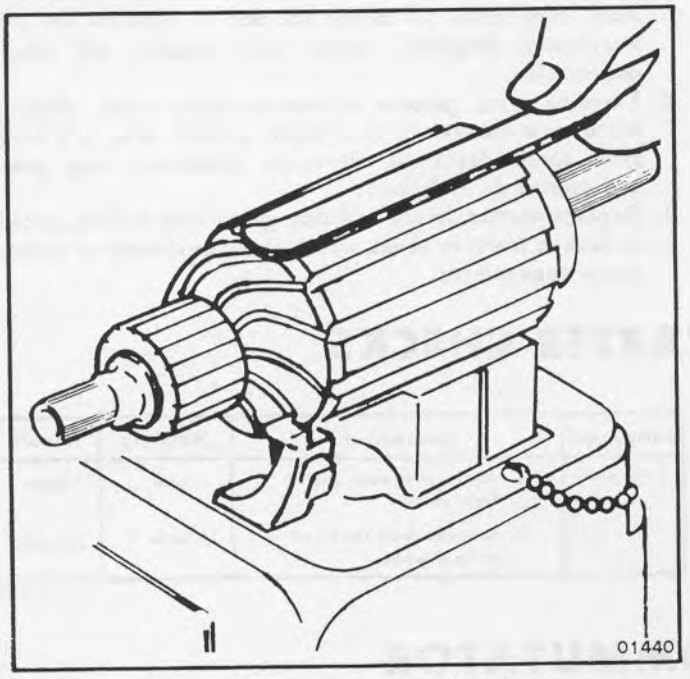

Figure 6. Armature Test for Shorts

ARMATURE TEST FOR GROUND

1. With Magneto Analyzer (C-91-25213) selector switch set on Scale No. 3 (Continuity), or using VOA Tester (C-91-52751) on Rx1 scale, place one lead on armature core or shaft and other lead on commutator.
2. If meter hand on Analyzer or VOA Tester moves to right, armature is grounded and must be replaced. (Figure 7)

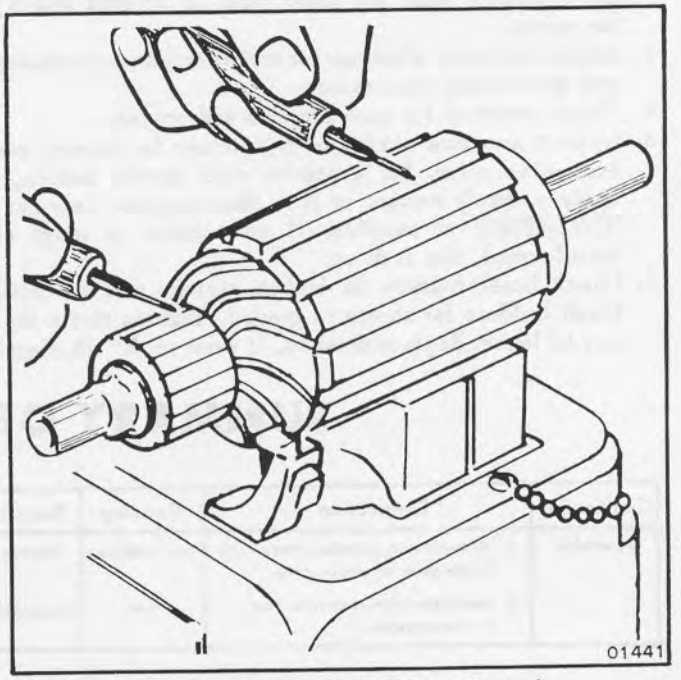

Figure 7. Armature Test for Ground

FIELD COIL

FIELD COIL TEST FOR OPEN CIRCUIT

1. With Magneto Analyzer selector switch set on Scale No. 3 (Continuity), or using VOA Tester on Rx1 scale, place one lead on each end of field coils.

2. If meter hand on Analyzer or VOA Tester does not move to right, field coils are open and must be replaced. (Figure 8)

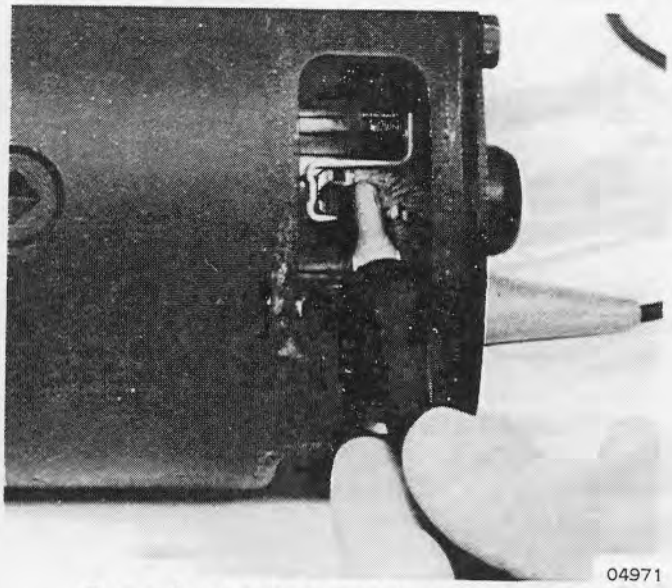

Figure 8. Field Coil Test for Open Circuit

FIELD COIL TEST FOR GROUND

1 With Magneto Analyzer selector switch set on Scale No. 3 (Continuity), or using VOA Tester on Rx1 scale, place one lead on field coil connector and other lead on field frame.

2. If meter hand moves to right, field coils are grounded. (Figure 9)

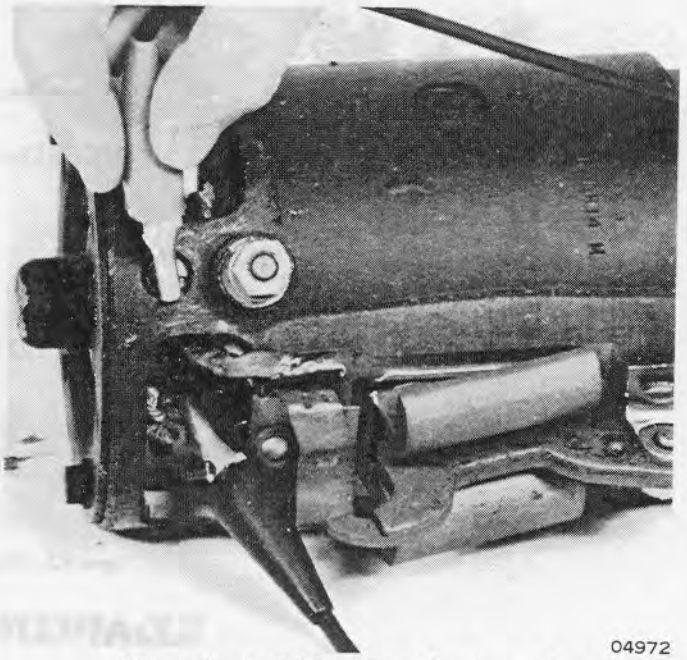

Figure 9. Field Coil Test for Ground

CLEANING and INSPECTION

1. Use a brush or air to clean field coils, armature, commutator, armature shaft, brush end plate and drive end housing. Wash all other parts in solvent and dry the parts.
2. Inspect armature windings for broken or burned insulation and unsoldered connections.
3. Check armature for open circuits and grounds.
4. Inspect armature shaft and 2 bearings for scoring and excessive wear. On a starter with needle bearings, apply a small amount of New Multipurpose Lubricant (C-92-49588) to needles. If commutator is rough or out-of-round, turn it down.
5. Check brush holders for broken springs and insulated brush holders for shorts to ground. Tighten rivets that may be loose. Replace brushes, if worn to ¼" (6.35mm) in length.
6. Check brush spring tension. Replace springs if tension is not within specified limits (40 ounces minimum)
7. Inspect field coils for burned or broken insulation and continuity. Check field brush connections and lead insulation. (A brush kit and a contact kit are available.) Replace, rather than repair, all other assemblies.
8. Examine wear pattern on starter drive teeth. Pinion teeth must penetrate to a depth greater than 1/2 ring gear tooth depth to eliminate premature ring gear and starter drive failure.
9. Replace starter drives and ring gears with milled, pitted or broken teeth or those which show evidence of inadequate engagement.

SUMMARY OF STARTER CHECKS

Component	Connection	Reading	Result
Armature	1. Armature on growler. Hack saw blade over armature core.	Saw vibrates	Shorted
	2. Analyzer from armature core to commutator.	Low	Grounded

Component	Connection	Reading	Result
Field Coil	1. Analyzer to each end of field coils.	Low	Open
	2. Analyzer from field coil to field frame.	Low	Grounded

TURNING the COMMUTATOR

Follow same procedure as outlined in Delco-Remy starter, preceding.

REASSEMBLY

1. Install starter terminal, insulator, washers and retaining nut in frame. (Figure 10) Be sure to position slot in screw perpendicular to frame end surface.
2. Position coils and pole pieces with coil leads in terminal screw slot, then install retaining screws. (Figure 5) As pole shoe screws are tightened, strike frame several sharp blows with a soft-faced hammer to seat and align pole shoes, then stake the screws.
3. Install solenoid coil and retainer and bend tabs to retain coils to frame.
4. Solder the field coils and solenoid wire to starter terminal, using rosin core solder. Use a 300-watt iron.
5. Check for continuity and grounds in assembled coils.
6. Position new insulated field brushes lead on field coil terminal. Install clip (provided with brushes) to hold brush lead to terminal. Solder the lead, clip and terminal together, using rosin core solder (Figure 10) Use a 300-watt iron.
7. Position solenoid coil ground terminal over nearest ground screw hole.
8. Position ground brushes to starter frame and install retaining screws. (Figure 10)
9. Position starter brush end plate to frame with end plate boss in frame slot.
10. Apply thin coat of New Multipurpose Lubricant (C-92-49588) on armature shaft splines. Install starter motor drive gear assembly to armature shaft and install new retaining stop ring. Install new stop ring retainer.
11. Position fiber thrust washer on commutator end of armature shaft and position armature in starter frame.
12. Position starter drive gear plunger lever to frame and starter drive assembly and install pivot pin.
13. Position starter drive plunger lever return spring and drive end housing to frame and install and tighten thru bolts to specification (55-75 inch pounds). DO NOT pinch brush leads between brush plate and frame. Be sure that stop ring retainer is seated properly in drive housing.

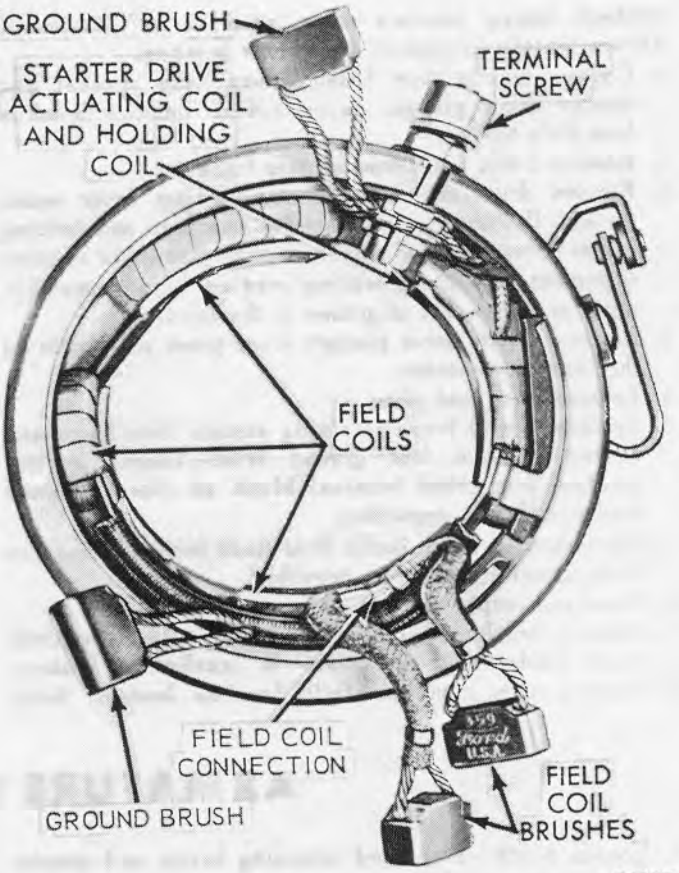

Figure 10. Field Coil Assembly

14. Install brushes in brush holders. Be sure to center brush springs on brushes.
15. Position drive gear plunger lever cover on starter and install brush cover band with gasket. Tighten band retaining screw.
16. Check starter no-load current draw.

STARTER DRIVE REPLACEMENT

1. Loosen and remove brush cover band and starter drive plunger lever cover. (Figure 5)
2. Loosen thru bolts to allow removal of drive end housing and starter drive plunger lever return spring. If starter has a needle bearing, and bearing is not being replaced, insert a dummy shaft in housing to prevent loss of any bearing needles. Before assembly, apply small amount of grease to needles.
3. Remove pivot pin (retaining starter drive plunger lever) and remove lever.
4. Remove drive gear stop ring retainer and stop ring from end of armature shaft and remove drive gear assembly.
5. Apply thin coat of New Multipurpose Lubricant (C-92-49588) on armature shaft splines. Install drive gear assembly on armature shaft and install new stop ring.
6. Position starter gear plunger lever on starter frame and install pivot pin. Be sure that plunger lever properly engages starter drive assembly.
7. Install new stop-ring retainer. Position starter drive plunger lever return spring and drive end housing to starter frame, then tighten thru bolts to 55-75 in. lbs. (9.8-13.3 kg/cm).
8. Position starter drive plunger lever cover and brush cover band (with its gasket) on starter. Tighten brush cover band retaining screw.

BRUSH REPLACEMENT

Replace starter brushes when worn to ¼" (6.35mm). Always install a complete set of new brushes.

1. Loosen and remove brush cover band, gasket and starter drive plunger lever cover. Remove brushes from their holders.
2. Remove 2 thru bolts from starter frame.
3. Remove drive end housing and plunger lever return spring. If starter has a needle bearing, and bearing is not being replaced, insert a dummy shaft in housing to prevent loss of any bearing needles. Before assembly, apply small amount of grease to the needles.
4. Remove starter drive plunger lever pivot pin and lever, then remove armature.
5. Remove brush end plate.
6. Remove ground brush retaining screws from frame and remove brushes (cut ground brush nearest starter terminal from brush terminal block as close to brush lead terminal as possible).
7. Cut insulated brush leads from field coils as close to field connection point as possible.
8. Clean and inspect starter motor.
9. Replace brush end plate, if insulator between field brush holder and end plate is cracked or broken.
10. Position new insulated field brushes lead on field coil connection. Position and crimp clip (provided with brushes) to hold brush lead to connection. Solder lead, clip and connection together, using rosin core solder. (Figure 10) Use a 300-watt iron.
11. Install ground brush leads to frame with retaining screws. Ground brush with over-size, unthreaded hole is placed under terminal from which previous ground brush was cut.
12. Clean commutator with 00 or 000 sandpaper.
13. Position brush end plate to starter frame with end plate boss in frame slot.
14. Position fiber washer on commutator end of armature shaft and install armature in starter frame.
15. Install starter drive gear plunger lever to frame and starter frame assembly, then install pivot pin.
16. Position return spring on plunger lever and drive end housing to starter frame. Install thru bolts and torque to 55-75 in. lbs. (9.8-13.3kg/cm). Be sure that stop ring retainer is seated properly in drive end housing.
17. Install commutator brushes in brush holders. Center brush springs on brushes.
18. Position plunger lever cover and brush cover band (with its gasket) on starter. Tighten band retaining screw.
19. Connect starter to a battery to check its operation.

ARMATURE REPLACEMENT

1. Loosen brush cover band retaining screw and remove brush cover band, gasket and starter drive plunger lever cover. Remove brushes from their holders.
2. Remove thru bolts, drive end housing and drive plunger lever return spring. If starter has a needle bearing, and bearing is not being replaced, insert a dummy shaft in housing to prevent loss of any bearing needles. Before assembly, apply small amount of grease to needles.
3. Remove pivot pin (retaining starter gear plunger lever) and remove lever.
4. Remove armature. If starter drive gear assembly is being reused, remove stop ring retainer and stop ring from end of armature shaft and remove drive.
5. Place drive gear assembly on new armature with a new stop ring.
6. Install fiber thrust washer on commutator end of armature shaft and install armature.
7. Position drive gear plunger lever to frame and drive gear assembly and install pivot pin.
8. Position drive plunger lever return spring, drive end housing and front end plate to starter frame, then install and tighten thru bolts to specification. Be sure that stop ring retainer is seated properly in drive housing.
9. Place brushes in their holders and center brush springs on brushes.
10. Position plunger lever cover and brush cover band (with its gasket), then tighten retaining screw.
11. Connect starter to a battery to check its operation.

LUBRICATION

Periodic lubrication of starting motor is not required.

INSTALLATION

1. Position starter assembly to flywheel housing and start mounting bolts.
2. Snug all bolts while holding starter squarely against its mounting surface and fully inserted into pilot hole. Torque bolts to specification.
3. Connect starter cable.

SPECIFICATIONS

Refer to "Specifications" Section 8 for starter specifications.

SOLENOID

REMOVAL

NOTE: All MerCruiser, except "60", "80", "90" and "215".

1. Remove starting motor as previously described.
2. Remove outer screw and washer from motor connector strap terminal.
3. Remove 2 screws which retain solenoid housing to drive housing.
4. Twist solenoid clockwise to remove flange key from keyway slot in housing, then remove solenoid assembly.

REPLACEMENT of CONTACTS

NOTE: For MerCruiser "60", "80" and "90", replace entire solonoid.

1. With solenoid removed from motor, remove nuts and washers from switch ("S") and motor connector strap terminals.
2. Remove 2 solenoid end cover retaining screws and washers and remove end cover from solenoid body.
3. Conpress solenoid plunger contact ring slightly and remove outer spring, retainer, fiber washer and contact ring. (Figure 1)
4. Remove nut and washer from battery terminal on end cover and remove battery terminal.
5. Remove motor connector strap terminal and solder new terminal in position.
6. Using a new battery terminal, install terminal, washer and retaining nut to end cover.
7. Place new contact ring and fiber washer on plunger, compress contact ring and install retainer and outer spring.
8. Position end cover over switch and motor terminals and install end cover retaining screws. Also install washers and nuts on solenoid switch and starting motor terminals.

SOLENOID INSTALLATION

1. Place solenoid in position on starter motor and twist solenoid counterclockwise to engage flange key in slot in housing.
2. Apply Gasket Sealer Compound (C-92-28804) to flange and field frame slot.
3. Install 2 solenoid to drive housing screws.
4. Bench test solenoid for proper operation and check pinion clearance as instructed.
5. Install starter motor on engine and test operation as instructed.

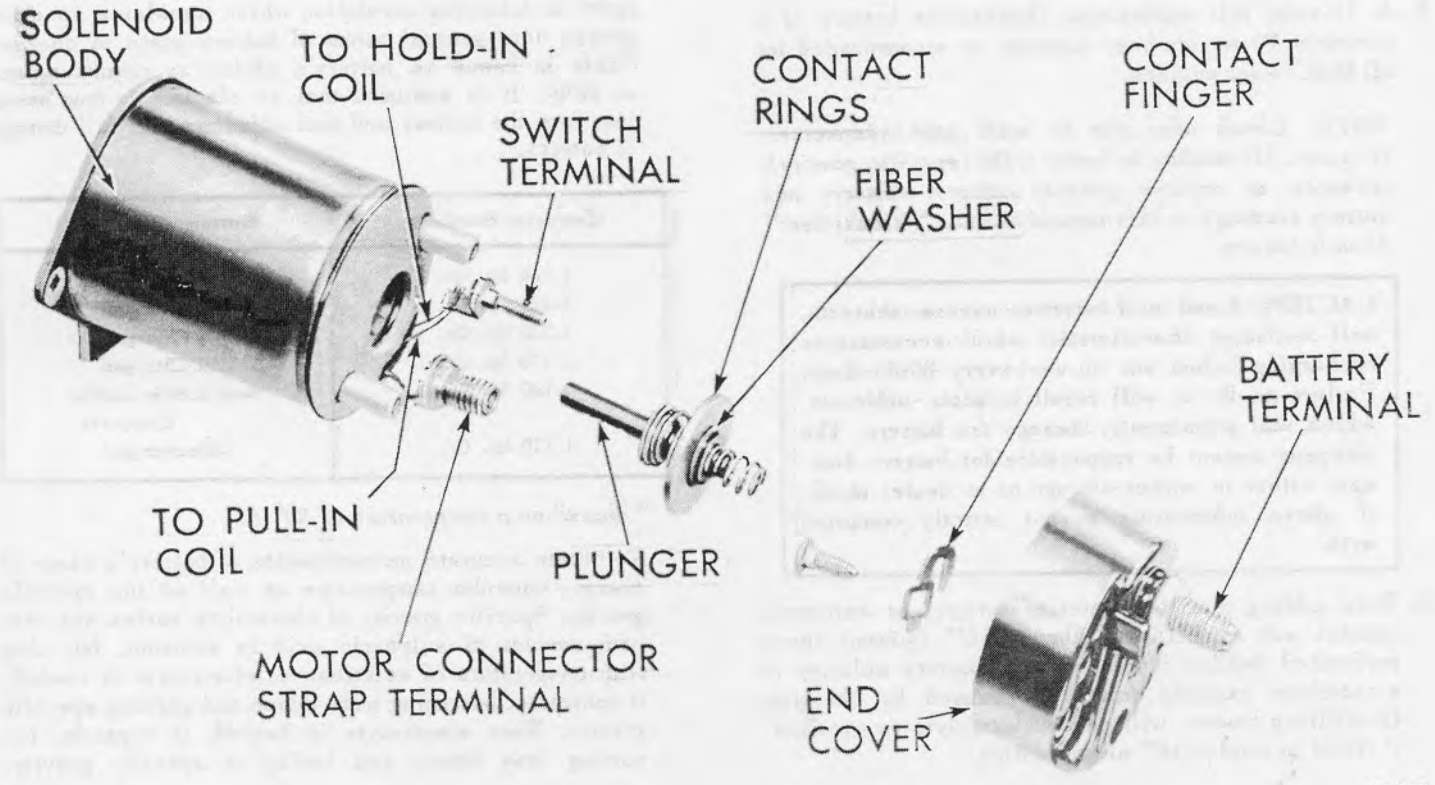

Figure 1. Exploded View of Solenoid

STORAGE BATTERY

MAINTENANCE

1. A strong battery must be maintained. If battery shows less than 9½ volts when under starting load, it should be recharged. Check with DC voltmeter. A reading under 9½ volts (measured at battery terminals under starting load) indicates insufficient voltage and subsequent shortage of power with result that motor will not turn fast enough to start.

NOTE: When installing a new battery, make it a habit to wire brush tapered terminals and clamp terminals, then clean and grease them. This will protect against high resistance connections which make it difficult to keep battery fully charged and may contribute to low available voltage in entire electrical starting system (and ignition system).

Figure 1. Testing with Hydrometer

2. A 12-volt, full marine-type Quicksilver battery of a minimum 70-ampere-hour capacity is recommended for all MerCruiser engines.

NOTE: Check also can be made with hydrometer. (Figure 1) If reading is below 1.230 (specific gravity), recharge or replace present battery. Battery and battery readings in this manual refer to "Quicksilver" 12-volt battery.

CAUTION: Lead acid batteries have an inherent, self-discharge characteristic which necessitates recharging (when not in use) every 30-45 days. Failure to do so will result in plate sulfation which will permanently damage the battery. The company cannot be responsible for battery damage, either in winter storage or in dealer stock, if above information is not strictly complied with.

3. When adding distilled water to battery, be extremely careful not to fill more than 3/16" (4.8mm) above perforated baffles inside battery. Battery solution or electrolyte expands from heat caused by charging. Overfilling battery will cause electrolyte to overflow, if filled beyond 3/16" above baffles.

4. If specific gravity drops below 1.230, check battery for reason and recharge battery. Battery recharge rate should not be over 4 amperes. When gravity reaches recommended gravity reading (see chart, following), discontinue charging.

AMPERE CAPACITY

1. New storage batteries, which are not initially fully charged, supply insufficient amperage and voltage capacity to starting (cranking) motor and results in few engine starts before battery no longer turns starter motor fast enough to start engine.

2. A dry-charge battery should not be filled with electrolyte until sold. After battery has been filled, wait 15 minutes and check specific gravity of each cell with a hydrometer. If specific gravity drops below 1.230 in any cell, bring battery up to full charge before placing in service. Bring battery to full charge with a slow charge for 2-to-3 hours at 5-6 ampere rate.

TABLE of GRAVITY READINGS

1. Specific gravity of electrolyte in a charged battery, which contains approximately 39 percent sulphuric acid, is 1.290. Specific gravity of a discharged battery, which contains approximately 14 percent acid, is 1.100. Specific gravity readings between these 2 extremes indicate various states of battery charge. Refer to following tabulation which translates specific gravity into general terms of battery state of charge. Table is based on battery's ability to crank engine at 80°F. It is assumed that no electrolyte has been lost from the battery and that adjustment at full charge is correct.

Capacity Reading*	Battery Condition
1.260 Sp. Gr.	100% Charged
1.230 Sp. Gr.	75% Charged
1.200 Sp. Gr.	50% Charged
1.170 Sp. Gr.	25% Charged
1.140 Sp. Gr.	Very Little Useful Capacity
1.110 Sp. Gr.	Discharged

** Based on a temperature of 80° F.*

2. To obtain accurate measurements of battery's state of charge, consider temperature as well as the specific gravity. Specific gravity of electrolyte varies not only with amount of sulphuric acid in solution, but also with temperature of solution. As electrolyte is cooled, it contracts, becoming more dense and gaining specific gravity. When electrolyte is heated, it expands, becoming less dense and losing in specific gravity.

BATTERIES in PARALLEL

1. To increase amperage hour capacity of a battery, connect 2 or more batteries together. Positive (+) terminal of one battery is connected to like terminal of second battery. Negative (-) terminal is connected to negative terminal of second battery. Two 35 ampere-hour capacity batteries in parallel are equal to 70 ampere-hours.

Example: 35 + 35 = 70 Ampere-Hours
70 + 70 = 140 Ampere-Hours

2. Any electrical accessories, such as horns, running lights, etc, should be installed with electrical connections attached directly to clamps on battery terminals.

CONVERTING ELECTRICAL ACCESSORIES

1. Following electrical accessories, if manufactured for a 6-volt system, may be converted to a 12-volt system:

Radio: Usually considerable internal modification. Refer most radios to radio expert only.

Stove: Change 6-volt elements to 12-volt elements on some; on others, change impossible.

Running Lights: Change to 12-volt bulbs or connect 2 identical bulbs in series.

Search Light: Change to 12-volt bulb or 12-volt sealed element.

Fuel Pump: Change to 12-volt fuel pump or consult manufacturer of pump on possible use of 6-volt pump on 12-volt system.

Bilge Pump: See fuel pump (above).

Horns: See fuel pump (above).

2. Rugged, attractive MercElectric battery boxes have been designed for Quicksilver aircraft-type batteries. New battery boxes, which can be mounted on transom of most boats, 1) hold battery snugly, 2) prevent damage to battery and boat, 3) protect battery cables and 4) facilitate easy installation and removal of battery from box.

WINTER STORAGE of BATTERIES

Battery companies are not responsible for battery damage either in winter storage or in dealer stock if the following instructions are not complied with:

1. Remove battery from its installation as soon as possible and remove all grease, sulfate and dirt from top surface by turning a hose on top of battery. Be sure, however, that vent caps are tight beforehand, and blow off all excess water thoroughly with compressed air. Check water level, making sure that plates are covered.
2. When adding distilled water to battery, be extremely careful not to fill more than 3/16" (4.8mm) above perforated baffles inside battery. Battery solution or electrolyte expands from heat caused by charging. Over-filling battery will cause electrolyte to overflow (if filled beyond 3/16" above baffles).
3. Grease terminal bolts well with cup grease or New Multipurpose Lubricant (C-92-49588) and store battery in COOL-DRY place. Remove battery from storage every 30-45 days, check water level and put on charge for 5 or 6 hours at 6 amperes. DO NOT FAST CHARGE.
4. If specific gravity drops below 1.240, check battery for reason and recharge. When gravity reaches 1.260, discontinue charging. To check specific gravity, use a hydrometer, which can be purchased locally. (Figure 1)
5. Repeat preceding charging procedure every 30-45 days, as long as battery is in storage, for best possible maintenance during inactive periods to insure a good serviceable battery in spring. When ready to place battery back in service, remove excess grease from terminals (a small amount is desireable on terminals at all times), recharge again as necessary and reinstall in your equipment.

When charging 2 or more batteries, connect them in series, positive (+) terminal of one to negative (-) terminal of next.

WARNING: Hydrogen and oxygen gases are produced during normal battery operation or charging. Sparks or flame can cause this mixture to ignite and explode, if they are brought near the vent openings. Sulphuric acid in battery can cause serious burns, if spilled on skin or in eyes. Flush or wash away immediately with clear water.

SECTION 3 - ELECTRICAL SYSTEM

MERCRUISER

PART B - IGNITION SYSTEM

MERCURY MARINE

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TOOLS

All "J-" (Special) Tools Listed in This Section May Be Purchased from:

Kent-Moore, Inc.
28635 Mound Road
Warren, Mich. 48089

IGNITION SYSTEM

DESCRIPTION

This section is divided into (1) breaker point ignition, (2) "60", "80" and "90" ignition system and (3) Thunderbolt Ignition. It covers general ignition system performance, specifications and adjustment procedures required within the ignition system. Removal, installation, cleaning and inspection and disassembly of the ignition components are included.

COMPONENTS

The breaker point ignition system consists of a distributor (including breaker points), ignition coil, ignition switch, battery, spark plugs and, on some models, a ballast resistor. The Thunderbolt Ignition System consists of a trigger assembly, ignition coil, switch box assembly, ignition switch, battery and spark plugs.

PRECAUTIONS

WARNING: When testing or servicing the ignition system, it is of extreme importance that the following precautions be observed, as high voltage is present. DO NOT touch or disconnect any ignition system parts while engine is running, key switch is on, or while battery cables are connected.

Failure to comply with the following may result in damage to the ignition system.

1. Do not reverse battery cable connections at the battery. System is negative (-) ground.
2. Do not "spark" battery terminals with battery cable connectors to check polarity.
3. Do not disconnect battery cables while engine is running.
4. Use only test equipment as specified. System cannot be checked with conventional ignition test equipment.
5. Follow service procedures in the order listed in the following information.

TROUBLESHOOTING

The Following Troubleshooting Chart Will Assist in Locating Source of Ignition Trouble.

Sympton	Probable Cause
Starter turns engine but hard to start or won't start.	A. Faulty coil or condenser. B. Moisture on ignition wires or distributor cap. C. Fouled spark plugs or improper plug gap. D. Improper ignition timing. E. Ignition points improperly gapped, burned or dirty. F. Cracked distributor cap or rotor. G. Poor connections or damaged ignition wiring.
Poor idling.	A. Loose distributor base plate bearing. B. Corroded wire ends or distributor towers. C. Incorrect distributor point gap. D. Fouled spark plugs or improper plug gap. E. Incorrect ignition timing. F. Overheated spark plugs.
Engine misses while idling.	A. Dirty or incorrectly gapped spark plugs; cracked porcelain. B. Broken or loose ignition wires. C. Burned or pitted contact points. D. Faulty coil or condenser. E. Weak battery. F. Distributor cap or rotor cracked or burned. G. Incorrect distributor advance or point dwell. H. Moisture on ignition wires, distributor cap or spark plugs. I. Excessive play in distributor shaft.
Engine has loss of power.	A. Incorrect ignition timing. B. Defective coil or condenser. C. Distributor rotor burned or cracked. D. Excessive play in distributor shaft. E. Worn distributor cam. F. Dirty or incorrectly gapped spark plugs

Symptom	Probable Cause
Engine misses on acceleration.	A. Distributor contact points dirty or improperly gapped. B. Coil or condenser defective. C. Spark plugs dirty or gap too great. D. Incorrect ignition timing.
Engine misses at high speed.	A. Defective coil or condenser. B. Incorrect ignition timing. C. Distributor contact points dirty or incorrectly gapped. D. Distributor rotor burned or cracked. E. Excessive play in distributor shaft. F. Spark plugs dirty or gap set too wide. G. Distributor shaft cam worn. H. Faulty ignition wiring.
Engine backfires.	A. Spark plug cables improperly installed. B. Improper distributor timing.
Engine knocks or pings (most noticeable on quick acceleration or at full throttle).	A. Incorrect spark plugs. B. Ignition timing advanced too far.
Excessive fuel consumption.	A. Incorrect ignition timing. B. Faulty distributor advance. C. Fouled spark plugs.
Poor acceleration.	A. Faulty coil. B. Loose distributor base plate bearing. C. Distributor not advancing properly. D. Incorrect ignition timing. E. Incorrect spark plug gap. F. Fouled spark plugs. G. Overheated spark plugs.
Fouled spark plugs.	Improper plug gap adjustment.
Burned spark plugs.	A. Improper plug heat range. B. Improper ignition timing.

BREAKER POINT IGNITION

MERCRUISER 4 and 6-CYLINDER ENGINES

INSPECTION

1. Remove distributor cap, clean cap and inspect for cracks, carbon tracks and burned-out or corroded terminals. Replace cap if necessary.
2. Make sure all distributor wire terminals are clean and tight.
3. Clean rotor and inspect for damage or deterioration. Replace rotor if necessary.

NOTE: Use notch on outer edge of distributor cap as a guide for proper replacement (over primary wire) of cap. It is possible to install incorrectly.

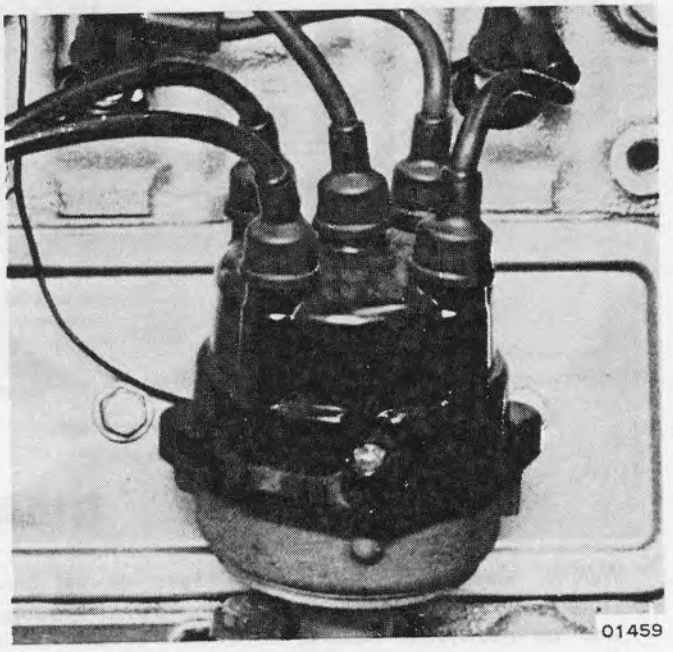


Figure 1. Breaker Point Distributor

LUBRICATION

1. Remove distributor cap every 100 hours.
2. Apply small amount of suitable high-melting-point, non-bleeding grease on distributor cam surface.

CAM WICK REPLACEMENT

1. Distributors, equipped with cam lubricator, should have wick replaced at same time contact point set is replaced.
2. It is not necessary to lubricate breaker cam when using a cam lubricator. DO NOT ATTEMPT TO LUBRICATE THE WICK. Replace if necessary.
3. When installing new wick, adjust its position so that end of wick just touches lobe of breaker cam.

ADJUSTING IGNITION POINTS

(See "Ignition Contact Points", following in this section.)

REMOVAL (4 and 6-CYLINDER)

NOTE: If necessary to remove secondary leads from distributor cap, mark position on cap tower for lead to No. 1 cylinder. This will aid in reinstallation of leads in cap. Refer to Section 8 "Specifications" for left hand or right hand rotation firing order.

1. Disconnect distributor primary lead from coil terminal.
2. Scratch a realignment mark on distributor in line with rotor segment. (Figure 2)
3. Remove distributor hold-down bolt and clamp and remove distributor from engine. Note position of assembly relative to engine for correct reinstallation. (Figure 3)

CAUTION: Avoid rotating engine with distributor removed, as ignition timing will be upset.

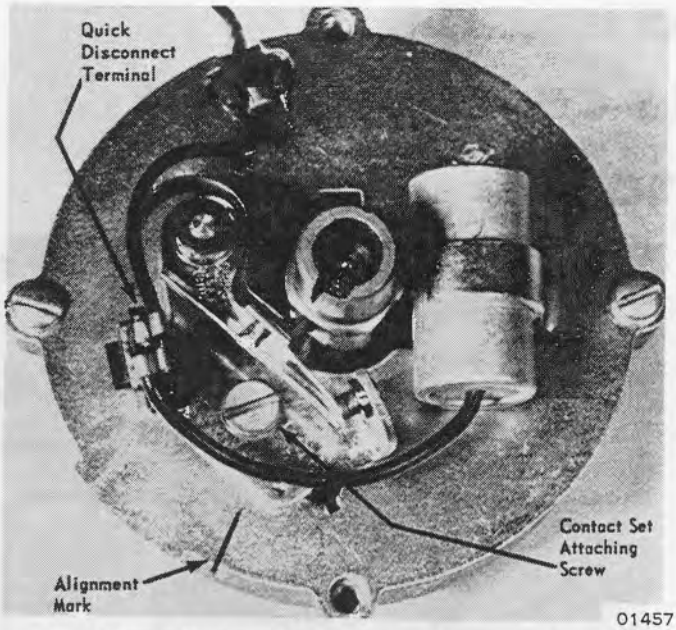


Figure 2. Breaker Plate and Attaching Parts

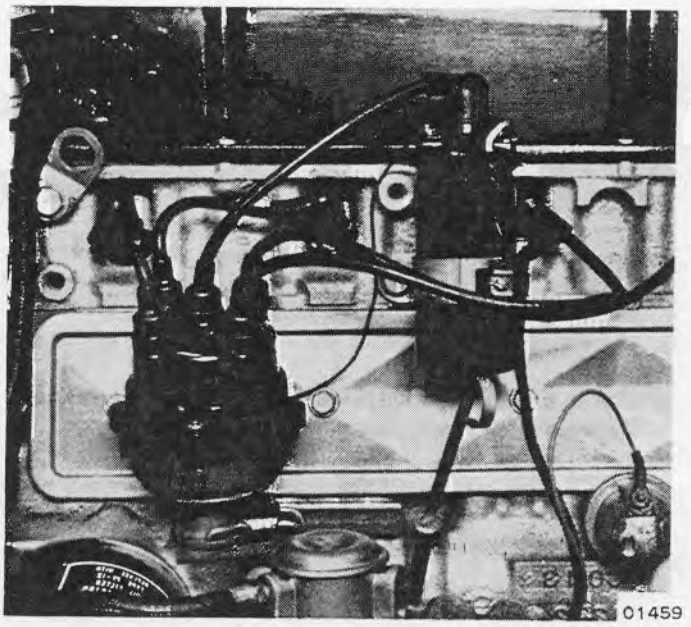


Figure 3. Distributor Location

DISASSEMBLY

NOTE: Late model distributors have an oil seal (located in distributor housing above upper bushing) and an additional bushing on bottom of distributor housing.

1. With distributor removed from engine, it is advisable to place it in a distributor testing machine or synchroscope.
2. When mounting distributor for tests, first secure gear in drive mechanism, then push distributor housing down toward gear to take up end play between gear and housing and, finally, secure housing in tester.

NOTE: Dwell is not set during bench test. This distributor depends upon its shaft bushing and engine drive gear for rigidity. Unless a special collar is used during bench test, shaft "wobble" may give an inaccurate dwell reading.

3. Test distributor for variation of spark, correct centrifugal advance and condition of contacts. This test evaluates distributor condition and possible parts replacement. Check area on breaker plate just beneath breaker points. A smudgy line indicates that oil or crankcase vapors are present between points.
   Refer to Figure 4 for exploded view of distributor.
4. Remove rotor.
5. Disconnect primary and condenser leads from contact point quick disconnect terminal. Remove contact point set attaching screw, condenser attaching screw and remove point set and condenser from breaker plate.
6. Remove breaker plate attaching screws and remove breaker plate from distributor housing. (Figure 2)

   NOTE: Do not further disassemble breaker plate.

7. Remove roll pin retaining driven gear to main shaft and slide gear from shaft.
8. Slide cam and mainshaft from distributor housing.
9. Remove weight cover and stop plate screws. Remove cover, weight springs, weights and slide cam assembly from mainshaft.
10. Remove main shaft bushing felt washer from housing.

    NOTE: Main shaft bushings in housing are not serviced separetely. Housing and bushings are serviced as complete assembly.

11. Remove gasket from shaft housing.

CLEANING and INSPECTION

1. Wash all parts in cleaning solvent, except cap, rotor condenser, breaker plate assembly and vacuum control unit (if present). Degreasing compounds may damage insulation of these parts or saturate lubricating felt in case of breaker plate assembly.
2. Inspect breaker plate assembly for damage or wear and replace if necessary.
3. Inspect shaft for wear and check its fit in bushings in distributor body. If shaft or bushings are worn, replace shaft and distributor body.
4. Mount shaft in "V" blocks and check shaft alignment with a dial gauge. Run-out should not exceed .002" (.051mm).
5. Inspect governor weights for wear or burrs and free fit on their pins.
6. Inspect cam for wear or roughness, then check its fit on end of shaft. It should be free, but not loose.
7. Examine distributor points. Dirty points should be cleaned with a clean point file. Normal point condition is an overall grey color.
8. If a test instrument for checking resistance is available, check point resistance.
9. Evaluate point quality by visual inspection and a resistance or voltage drop check.
10. Replace points if badly worn, pitted or misaligned.
11. If, with points closed and ignition switch in "On" position, less than a 0.125 volt drop exists across points, points are satisfactory. Make this check with a sensitive voltmeter or a point resistance meter available for this purpose.
12. Test condenser for series resistance, microfarad capacity (.18 to .23), leakage or breakdown, following instructions given by manufacturer of test equipment used.
13. Inspect distributor cap and spark plug wires for damage.

REASSEMBLY

1. Refer to Figure 6 for exploded view of distributor. Replace cam assembly to mainshaft.

   NOTE: Lubricate top end of shaft with light engine oil prior to replacement.

2. Install weights on their pivot pins and replace weight springs. Install weight cover and stop plate. (Figure 4)
3. Lubricate mainshaft and install it in distributor housing.
4. Install distributor driven gear to mainshaft and insert retaining roll pin. Check that shaft turns freely.

   NOTE: Install driven gear with mark on hub in line with rotor segment.

5. Position breaker plate assembly in housing and attach retaining screws. (Figure 2)
6. Attach condenser and contact point set in proper location with appropriate attaching screws.

   NOTE: Contact point set pilot must engage matching hole in breaker plate. Connect primary and condenser leads to contact set quick disconnect terminal.

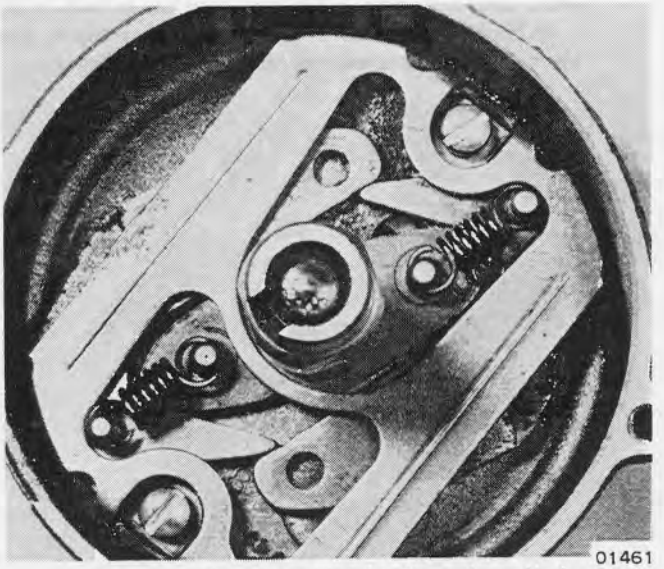


Figure 4. Weights, Weight Cover Installed

7. Install rotor to cam assembly.

INSTALLATION

ENGINE NOT DISTURBED

1. Turn rotor approximately 1/8-turn in a clockwise direction past mark previously scratched on distributor housing.
2. Work distributor down into position in engine block with distributor positioned as noted during removal.

   NOTE: It may be necessary to move rotor slightly to start gear into mesh with camshaft gear, but rotor should line up with the mark when distributor is down in place.

3. Replace and tighten distributor hold-down bolt and clamp. Connect primary lead to coil. Also install spark plug and coil secondary wires, if removed. (Figure 5)

   NOTE: Wires must be installed, as indicated, to prevent cross-firing. Refer to Section 8 "Specifications" for left hand or right hand rotation firing order.

4. Time ignition as outlined under "Ignition Timing".

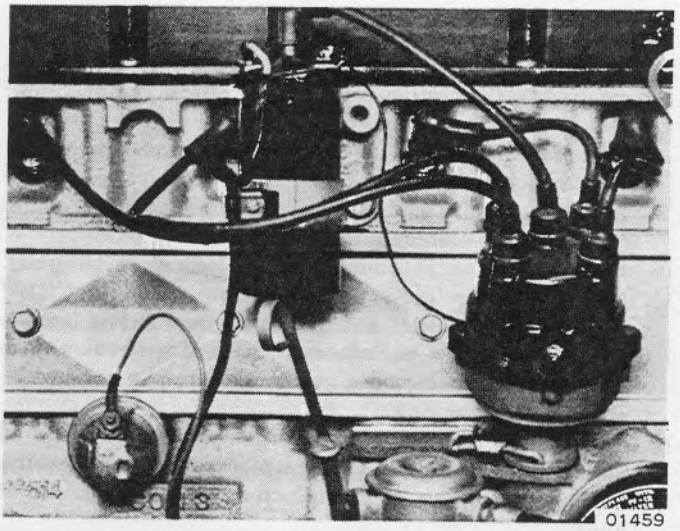


Figure 5. Distributor Installed

ENGINE DISTURBED

1. Locate No. 1 piston in firing position by either of 2 methods described below.
   a. Remove No. 1 spark plug and, with finger on plug hole, crank engine until compression is felt in No. 1 cylinder. Continue cranking until pointer lines up with timing mark on crank shaft pulley or . . .
   b. Remove rocker cover and crank engine until No. 1 intake valve closes, continuing to crank slowly until pointer lines up with timing mark on crankshaft pulley.
2. Position distributor to opening in block in normal installed attitude.
3. Position rotor to point toward front of engine (with distributor housing held in installed attitude), then turn rotor counterclockwise approximately 1/8-turn more toward left and push distributor down to engage camshaft. It may be necessary to rotate rotor slightly until camshaft engagement is felt.
4. While pressing down firmly on distributor housing, kick starter over a few times to make sure oil pump shaft is engaged. Install hold-down clamp and bolt and snug up bolt.
5. Turn distributor body slightly until points just open and tighten distributor clamp bolt.
6. Place distributor cap in position and check that rotor lines up with terminal for No. 1 spark plug.
7. Install cap, distributor primary lead to coil. Check all high tension wire connections and connect spark plug wires, if they have been removed. (Figure 5) Wires must be installed in their proper location in supports to prevent cross-firing.
8. Start engine and set timing described under "Ignition Timing", following in this section.

1 Distributor Assembly
2 Gear, drive - main shaft
3 Main Shaft & Weight Plate
4 Pin
5 Cam, breaker
6 Weight
7 Spring
8 Plate
9 Screw
10 Plate, mounting
11 Screw
12 Condenser
13 Breaker Assembly
14 Screw
15 Grommet
16 Lead, primary
17 Rotor, distributor
18 Washer, rotor
19 Cap, distributor
20 Button, carbon
21 Screw
22 Screw
23 Gasket, distributor
24 Lead Assembly
25 Lead Assembly
26 Lead Assembly
27 Lead Assembly
28 Protector
29 Spark Plug (AC#R-44T)
30 Retainer
31 Retainer
32 Wire Assembly
33 Coil Assembly
34 Bracket
35 Screw
36 Washer
37 Nut
38 Screw
39 Washer
40 Screw
41 Clamp Unit
42 Retainer

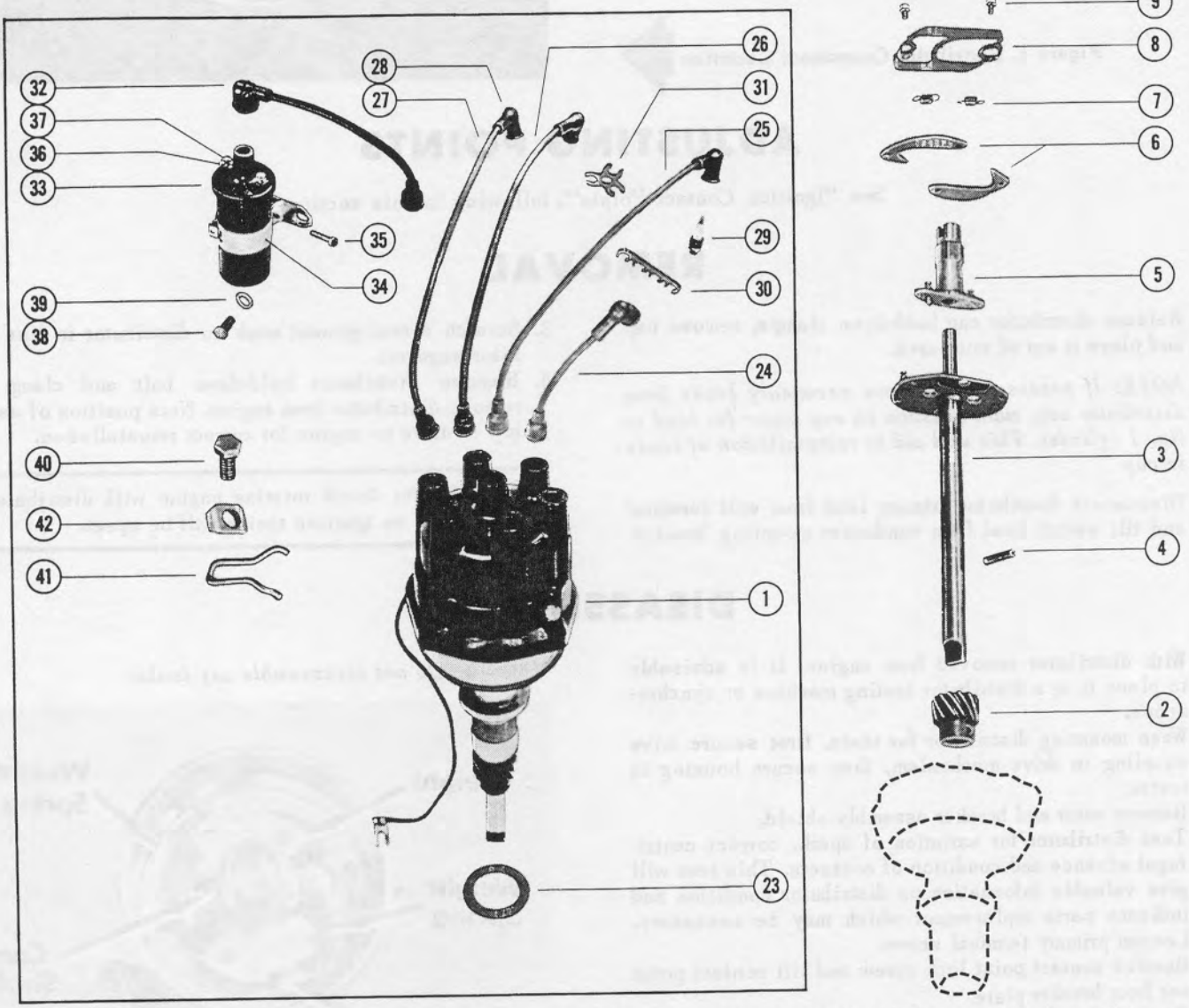


Figure 6. Distributor, 4 and 6-Cylinder Engines, Exploded View

MERCRUISER MARINE "60", "80", "90" IGNITION

MerCruiser "60", "80" and "90" Ignition Systems Are the Same as the 4 and 6-Cylinder Ignition System, except for the Following Procedures.

LUBRICATION

1. Remove distributor cap every 100 hours.
2. Apply small amount of suitable high-melting-point, non-bleeding grease on distributor cam surface.
3. Remove rotor and add a drop of light engine oil to felt pad located in top of distributor cam shaft. (Figure 1)

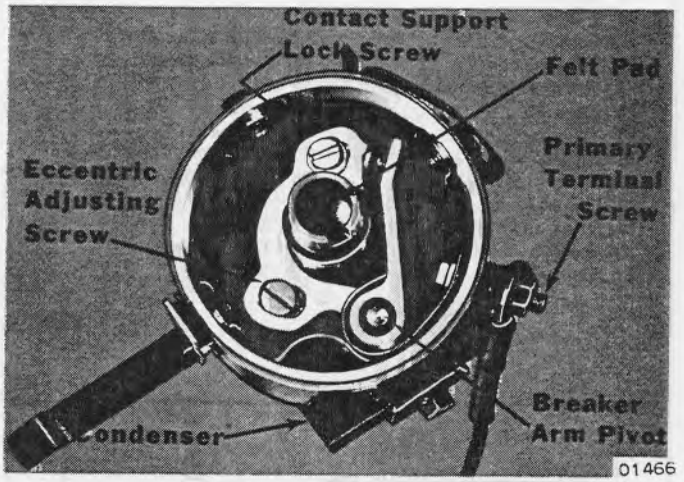


Figure 1. Distributor Component Location

ADJUSTING POINTS

See "Ignition Contact Points", following in this section.

REMOVAL

1. Release distributor cap hold-down clamps, remove cap and place it out of work area.

   NOTE: If necessary to remove secondary leads from distributor cap, mark position on cap tower for lead to No. 1 cylinder. This will aid in reinstallation of leads in cap.

2. Disconnect distributor primary lead from coil terminal and tilt switch lead from condenser mounting bracket.
3. Scratch a realignment mark on distributor in line with rotor segment.
4. Remove distributor hold-down bolt and clamp and remove distributor from engine. Note position of assembly relative to engine for correct reinstallation.

CAUTION: Avoid rotating engine with distributor removed, as ignition timing will be upset.

DISASSEMBLY

1. With distributor removed from engine, it is advisable to place it in a distributor testing machine or synchroscope.
2. When mounting distributor for tests, first secure drive coupling in drive mechanism, then secure housing in tester.
3. Remove rotor and breaker assembly shield.
4. Test distributor for variation of spark, correct centrifugal advance and condition of contacts. This test will give valuable information on distributor condition and indicate parts replacement which may be necessary.
5. Loosen primary terminal screw.
6. Remove contact point lock screw and lift contact point set from breaker plate.
7. Remove breaker plate attaching screws and remove breaker plate from distributor housing.
8. Remove weight springs and weights and slide cam assembly from mainshaft. (Figure 2)

Do not disassemble any further.

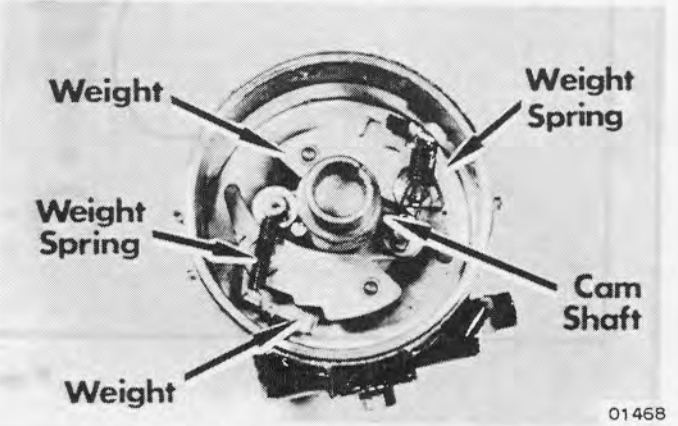


Figure 2. Weight Springs and Weights

CLEANING and INSPECTION (Figure 3)

1. Wash all parts in cleaning solvent, except cap, rotor condenser and breaker plate assembly. Degreasing compounds may damage insulation of these parts or saturate lubricating felt in case of breaker plate assembly.
2. Inspect breaker plate assembly for damage or wear and replace if necessary.
3. Inspect shaft for wear and check its fit in bushings in distributor body. If shaft or bushings are worn, distributor should be replaced.
4. Inspect governor weights for wear or burrs and free fit on their pins.
5. Inspect cam for wear or roughness, then check its fit on end of shaft. It should be absolutely free, without any looseness.
6. Inspect condition of distributor points. Clean dirty points and replace badly pitted points. (See "Ignition Contact Points", following.)
7. Test condenser for series resistance, microfarad capacity, leakage or breakdown, following instructions given by manufacturer of test equipment used.
8. Inspect distributor cap and spark plug wires for damage.

1 Distributor Cap Assembly
2 Ball & Spring Assembly
3 Distributor Rotor
4 Felt Washer
5 Breaker Assembly Shield
6 Screw
7 Washer
8 Breaker Assembly
9 Washer
10 Spring
11 Condenser
12 Lockwasher
13 Screw
14 Main Shaft Pin
15 Primary Terminal Screw
16 Retainer
17 Lockwasher
18 Screw
19 Spring Clip

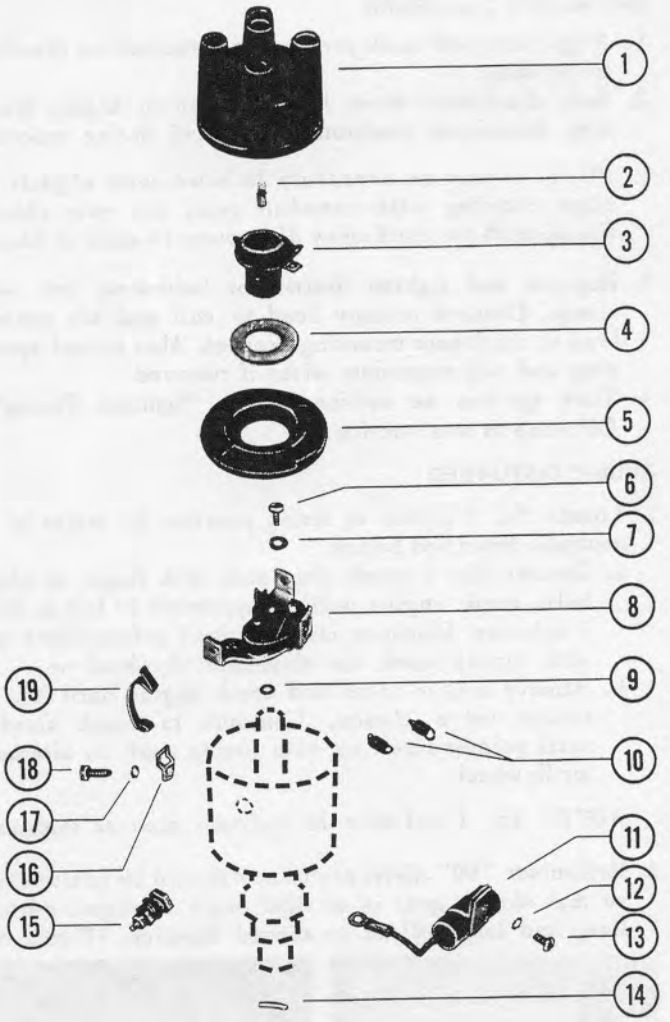


Figure 3. Exploded View of Distributor

REASSEMBLY

Refer to Figure 3 for exploded view of distributor.

1. Replace cam assembly to mainshaft.

   NOTE: Lubricate top end of shaft with light engine oil prior to replacing.

2. Install weights on their pivot pins and replace weight springs.
3. Position breaker plate assembly in housing and install attaching screws.
4. Place contact point assembly in position on breaker plate and install lock screw and tighten primary terminal screw.
5. Adjust points as described under "Setting and Alignment of Points", following this section.
6. Install breaker shield assembly and rotor.

INSTALLATION

ENGINE NOT DISTURBED

1. Align rotor with mark previously scratched on distributor housing.
2. Work distributor down into position in engine block with distributor positioned as noted during removal.

   NOTE: It may be necessary to move rotor slightly to align coupling with camshaft gear, but rotor should line up with the mark when distributor is down in place.

3. Replace and tighten distributor hold-down bolt and clamp. Connect primary lead to coil and tilt switch lead to condenser mounting bracket. Also install spark plug and coil secondary wires if removed.
4. Time ignition as outlined under "Ignition Timing", following in this section.

ENGINE DISTURBED

1. Locate No. 1 piston in firing position by either of 2 methods described below.
   a. Remove No. 1 spark plug and, with finger on plug hole, crank engine until compression is felt in No. 1 cylinder. Continue cranking until pointer lines up with timing mark on alternator flywheel or . . .
   b. Remove rocker cover and crank engine until No. 1 intake valve closes. Continue to crank slowly until pointer lines up with timing mark on alternator flywheel.

   NOTE: No. 1 cylinder is cylinder nearest transom.

2. MerCruiser "60": Drive pinion now should be positioned so that slot in gear is at right angle to engine center line, and large offset is toward dipstick. (Figure 4)

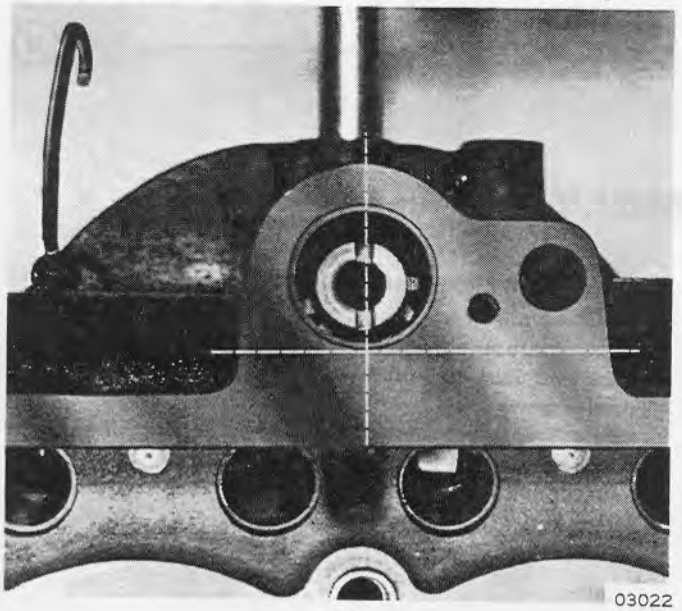


Figure 4.
Installing Distributor Drive Pinion for MerCruiser "60"

MerCruiser "80": Drive pinion now should be positioned so that slot in gear is in line with centerline and small offset is toward camshaft. (Figure 5)

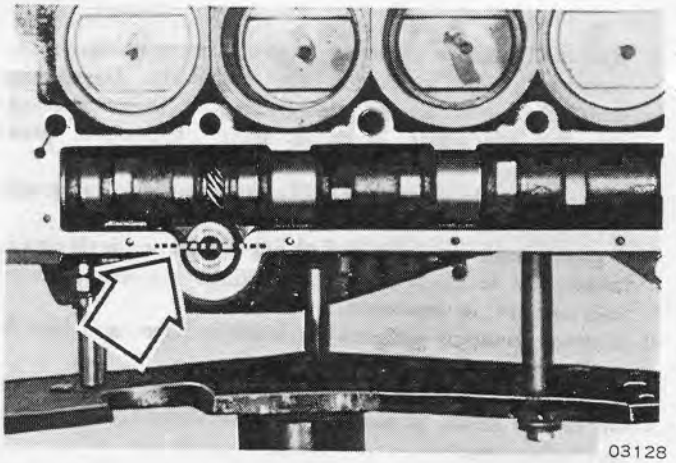


Figure 5.
Installing Distributor Drive Pinion for MerCruiser "80"

MerCruiser "90" Drive pinion now should be positioned so that slot in gear is at a 53° angle from centerline, which is square with camshaft, and with largest offset toward camshaft. (Figure 6)

3. Position rotor so that it is pointed at No. 1 spark plug terminal of distributor cap.
4. Place distributor body in position in cylinder block. It may be necessary to turn rotor slightly to align drive slot.

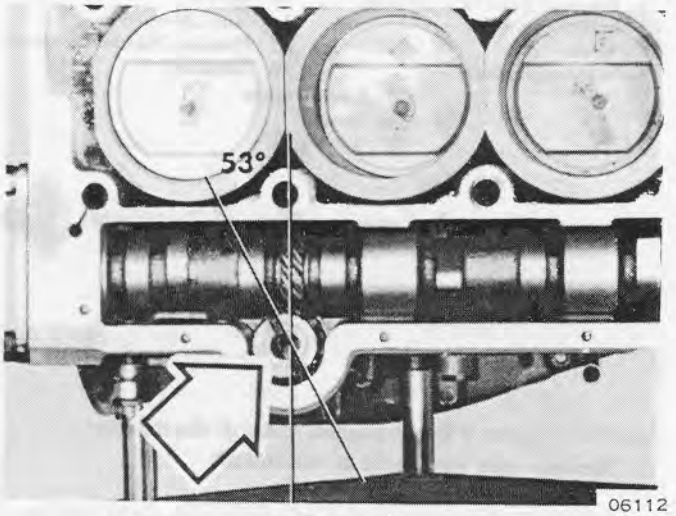


Figure 6.
Installing Distributor Drive Pinion for MerCruiser "90"

5. Turn distributor body slightly until points just open and tighten distributor hold-down clamp.
6. Place distributor cap in position and check that rotor lines up with terminal for No. 1 spark plug.
7. Install breaker shield assembly and rotor.
8. Install cap, distributor primary lead to coil and tilt switch lead to condenser mounting bracket. Check all high tension wire connections and connect spark plug wire, if removed.
9. Set timing as outlined under "Ignition Timing", following in this section.

DELCO-REMY 8-CYLINDER DISTRIBUTOR

INSPECTION

1. Remove distributor cap, clean cap and inspect for cracks, carbon tracks and burned-out or corroded terminals. Replace cap if necessary. (Figure 1)
2. Make sure all distributor wire terminals are clean and tight.
3. Clean rotor and inspect for damage or deterioration. Replace rotor if necessary.
4. Inspect breaker assembly for damage, wear and dirty or badly pitted points. Replace if necessary. (See "Ignition Contact Points", following.)

NOTE: Use notch on outer edge of distributor cap as a guide for proper replacement (over primary wire) of cap. It is possible to install incorrectly.

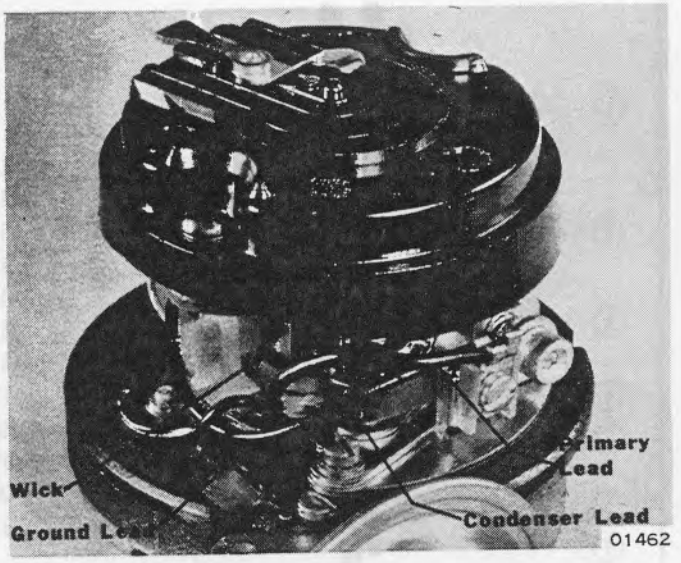


Figure 1. Breaker Point Distributor - 8-Cylinder

LUBRICATION

1. Remove distributor cap every 100 hours.
2. Apply small amount of suitable high-melting-point, non-bleeding grease on distributor cam surface.

CAM WICK REPLACEMENT

1. Distributors, equipped with cam lubricator, should have wick replaced at same time contact point set is replaced.
2. It is not necessary to lubricate breaker cam when using a cam lubricator. DO NOT ATTEMPT TO LUBRICATE THE WICK. Replace if necessary.
3. When installing new wick, adjust its position so that end of wick just touches lobe of breaker cam.

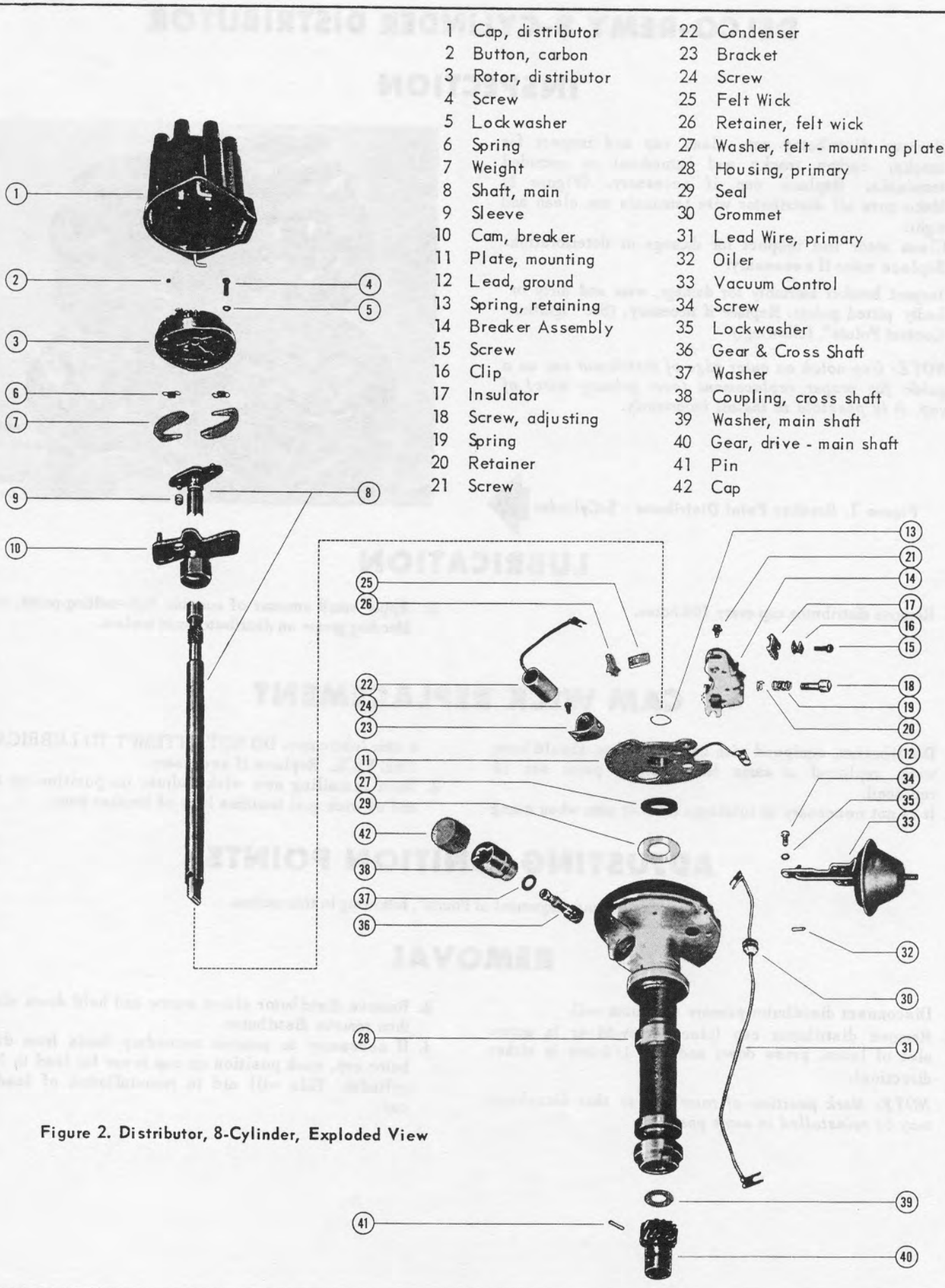
ADJUSTING IGNITION POINTS

See "Setting and Alignment of Points", following in this section.

REMOVAL

1. Disconnect distributor primary wire from coil.
2. Remove distributor cap (place screwdriver in screw slot of latch, press down and turn 1/4-turn in either direction).

   NOTE: Mark position of rotor arm so that distributor may be reinstalled in same position.
3. Remove distributor clamp screw and hold down clamp, then remove distributor.
4. If necessary to remove secondary leads from distributor cap, mark position on cap tower for lead to No. 1 cylinder. This will aid in reinstallation of leads in cap.



1	Cap, distributor	22	Condenser
2	Button, carbon	23	Bracket
3	Rotor, distributor	24	Screw
4	Screw	25	Felt Wick
5	Lockwasher	26	Retainer, felt wick
6	Spring	27	Washer, felt - mounting plate
7	Weight	28	Housing, primary
8	Shaft, main	29	Seal
9	Sleeve	30	Grommet
10	Cam, breaker	31	Lead Wire, primary
11	Plate, mounting	32	Oiler
12	Lead, ground	33	Vacuum Control
13	Spring, retaining	34	Screw
14	Breaker Assembly	35	Lockwasher
15	Screw	36	Gear & Cross Shaft
16	Clip	37	Washer
17	Insulator	38	Coupling, cross shaft
18	Screw, adjusting	39	Washer, main shaft
19	Spring	40	Gear, drive - main shaft
20	Retainer	41	Pin
21	Screw	42	Cap

Figure 2. Distributor, 8-Cylinder, Exploded View

DISASSEMBLY

It is advisable to place distributor in a distributor testing machine or synchroscope after removing from engine.

NOTE. When mounting distributor for tests, first secure gear in drive mechanism, then push distributor housing down toward gear to take up end play between gear and housing and, finally, secure housing in tester.

Test distributor for variation of spark, correct centrifugal advance and condition of contacts. This test evaluates distributor condition and possible parts replacement. Check area on breaker plate just beneath breaker points. A smudgy line indicates that oil or crankcase vapors are present between points.

1. Remove rotor.
2. Remove both weight springs and both advance weights. (Figure 2)
3. File off head of driven gear pin and drive out pin.
4. Slide gear off shaft.
5. Remove burrs around pin hole in shaft with flat file. These burrs will damage housing bushing if not removed before removal of shaft.
6. Pull shaft and cam weight base assembly from housing.
7. Remove circuit breaker cam and weight base assembly from shaft.
8. Remove condenser hold-down screw, condenser and bracket from breaker plate.
9. Remove cam lubricator.
10. Remove spring retainer and remove breaker plate from housing.
11. To remove vacuum advance unit (not used), remove 2 attaching screws and washers and plate ground lead.
12. Remove felt washer from around bushing in housing.
13. Remove gasket from shaft housing.

CLEANING and INSPECTION

NOTE: Shaft bushings in housing are not serviced. If bushings are defective, housing is serviced as complete assembly.

Refer to "Cleaning and Inspection", 4 and 6-cylinder models, preceding.

REASSEMBLY

(Refer to Figure 2)

1. Replace gasket on shaft housing.
2. Replace felt washer around bushing in housing.
3. Replace vacuum advance unit (not used).
4. Install breaker plate in housing and spring retainer on upper bushing.
5. Replace condenser.
6. Replace contact set assembly.
7. Replace cam and weight base assembly on shaft.

NOTE: If lubrication in grooves at top of shaft was removed during disassembly and inspection, replace with Plastilube No. 2.

8. Install shaft and cam weight assembly in housing.
9. Install driven gear to shaft with new pin.
10. Install advance weights and springs.
11. Install cam lubricator.
12. Replace rotor.
13. Check for dwell angle as described previously under "Adjusting of Dwell Angle."

INSTALLATION

ENGINE NOT DISTURBED

1. Turn rotor about 1/8-turn counterclockwise past mark previously placed on distributor housing.
2. Push distributor down into position in block with housing in normal "installed" position. (Figure 3)

NOTE: It may be necessary to move rotor slightly to start gear into mesh with camshaft gear, but rotor should line up with mark when distributor is down in place.

3. Tighten distributor clamp screw snugly, connect primary wire to terminal and install cap. Also install spark plug and high tension wires to cap if removed. (Figure 4) Be sure that spark plug wires are installed in proper locations in supports, as shown.

NOTE: Grommets are numbered to show correct installation. Wires must be installed as indicated to prevent cross-firing.

4. Time ignition as described in this section, following.

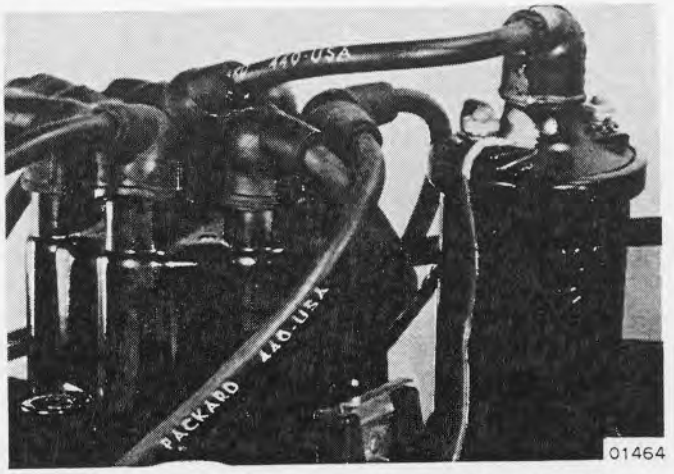


Figure 3. Eight-Cylinder Distributor and Coil

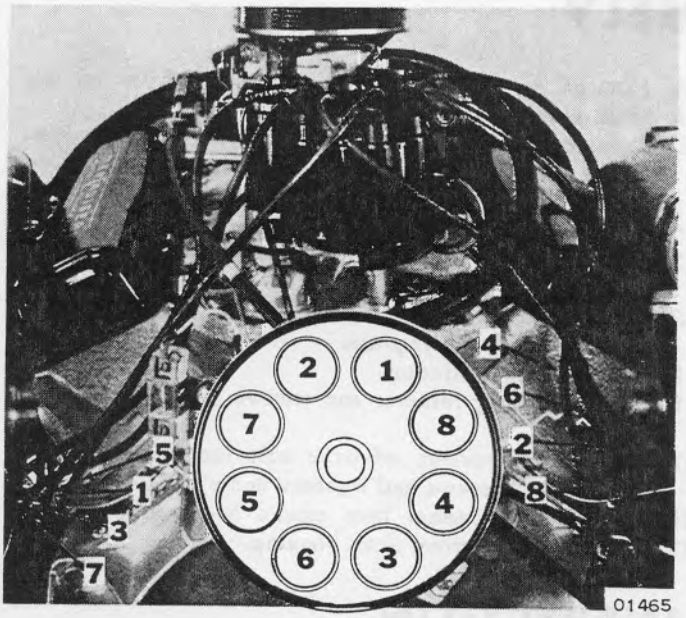


Figure 4.

Spark Plug Wire Installation - "283" V-8 Engine

ENGINE DISTURBED

1. Locate No. 1 piston in firing position by either of 2 methods ("a" or "b"), following:
   a. Remove No. 1 spark plug and, with finger on plug hole, crank engine until compression is felt in No. 1 cylinder. Continue cranking until pointer lines up with timing mark on crankshaft pulley, or
   b. Remove left bank rocker cover and crank engine until No. 1 intake valve closes, then continue to crank slowly until pointer lines up with timing mark on crankshaft pulley.
2. Position distributor to opening in block in normal installed attitude. See Figure 3, noting position of vacuum control unit.
3. Position rotor to point toward front of engine (with distributor housing held in installed attitude), then turn rotor counterclockwise approximately 1/8 - turn more toward left cylinder bank and push distributor down to engage camshaft. It may be necessary to rotate rotor slightly until camshaft engagement is felt.
4. While pressing firmly down on distributor housing, kick starter over a few times to make sure that oil pump shaft is engaged. Install hold-down clamp and bolt and snug up bolt.
5. Turn distributor body slightly until points just open and tighten distributor clamp bolt.
6. Place distributor cap in position and check that rotor lines up with terminal for No. 1 spark plug.
7. Install cap, check all high tension wire connections and connect spark plug wires if they have been removed. (Figure 4) Be certain that wires are installed in proper locations in supports.

   NOTE: Wires must be installed as indicated to prevent cross-firing.

8. Connect distributor primary wire to coil terminal.
9. Start engine and set timing as described under "Ignition Timing", following in this section.

AUTOLITE DISTRIBUTOR

INSPECTION, LUBRICATION and REMOVAL

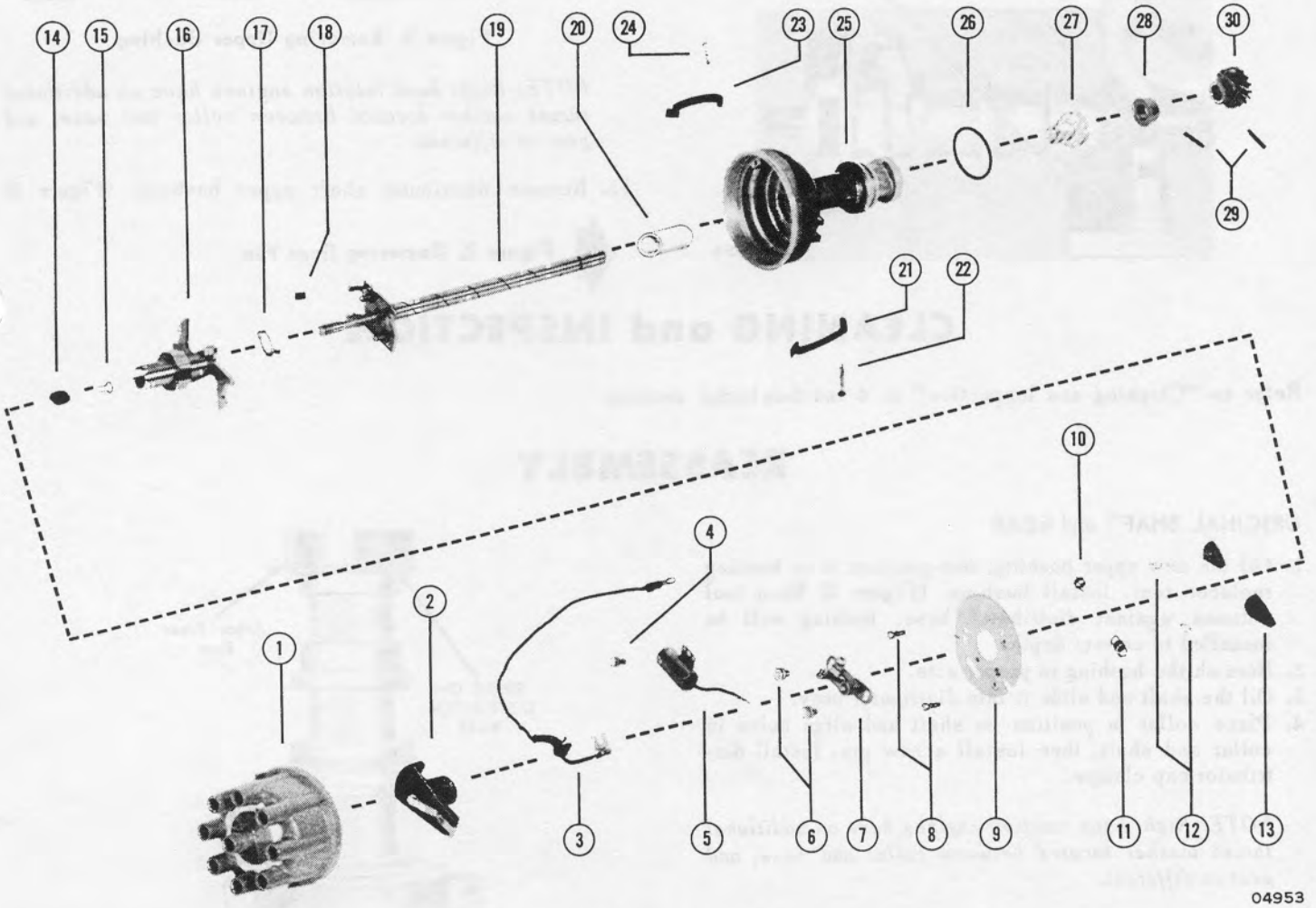
Refer to "Inspection", "Lubrication" and "Removal" under "Delco-Remy 8-Cylinder Distributor", preceding.

DISASSEMBLY

(Distributor is shown in Figure 1.)

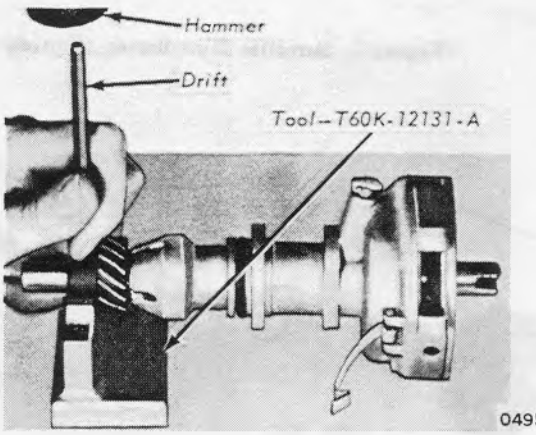
1. Remove rotor.
2. Disconnect primary and condenser wires from breaker point assembly.
3. Remove 2 screws and remove breaker point assembly.
4. Remove screw and remove condenser.
5. Working from inside of distributor, pull primary wire through opening in distributor.
6. Remove 2 screws and remove breaker plate.
7. Mark one of the distributor weight springs and its brackets. Also mark one of the weights and its pivot pin.

Figure 1. Autolite Distributor, Exploded View



1 Cap, distributor
2 Rotor
3 Primary Wire
4 Screw
5 Condenser
6 Screws
7 Breaker Point Assembly
8 Screws
9 Breaker Plate
10 Spring
11 Spring
12 Weight Retainer
13 Weight
14 Lubricating Wick
15 Retainer
16 Cam Assembly
17 Thrust Washer
18 Bumper
19 Shaft
20 Upper Bushing
21 Clamp
22 Pin
23 Clamp
24 Pin
25 Housing
26 Oil Seal
27 Thrust Washer (not used on standard rotation)
28 Collar
29 Pin
30 Gear

8. Carefully unhook and remove weight springs.
9. Lift lubricating wick from cam assembly. Remove cam assembly retainer and lift cam assembly off distributor shaft. Remove thrust washer.
10. Remove weight retainers and lift weights out of distributor.
11. Remove distributor cap clamps.
12. If gear and shaft are to be used again, mark gear and shaft so that pin holes can be easily aligned for assembly. Remove gear roll pin (Figure 2), then remove gear.
13. Remove shaft collar roll pin.
14. Invert distributor and place it on a support plate in a position that will allow distributor shaft to clear support plate. Press shaft out of collar and distributor housing.



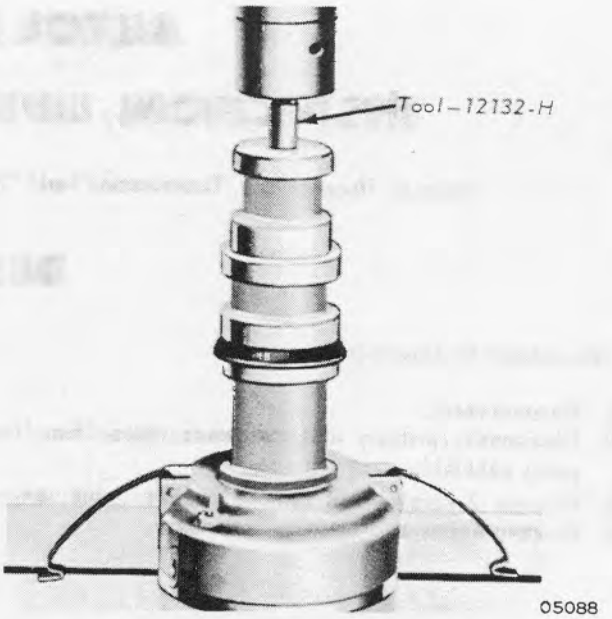


Figure 3. Removing Upper Bushing

NOTE: Right hand rotation engines have an additional thrust washer located between collar and base, and gear is different.

15. Remove distributor shaft upper bushing. (Figure 3)

Figure 2. Removing Gear Pin

CLEANING and INSPECTION

Refer to "Cleaning and Inspection" in 4 and 6-cylinder section.

REASSEMBLY

ORIGINAL SHAFT and GEAR

1. Oil the new upper bushing, and position it on bushing replacer tool. Install bushing. (Figure 4) When tool bottoms against distributor base, bushing will be installed to correct depth.
2. Burnish the bushing to proper size.
3. Oil the shaft and slide it into distributor body.
4. Place collar in position on shaft and align holes in collar and shaft, then install a new pin. Install distributor cap clamps.

   NOTE: Right hand rotation engines have an additional thrust washer located between collar and base, and gear is different.

5. Check shaft end play with a feeler gauge placed between collar and base of distributor. If end play is not within specifications, replace shaft and gear.
6. Attach distributor shaft supporting tool to distributor. Tighten backing screw in tool enough to remove all shaft end play.
7. Install assembly in a press. Press gear on shaft, using marks on gear and shaft as guides to align pin holes.

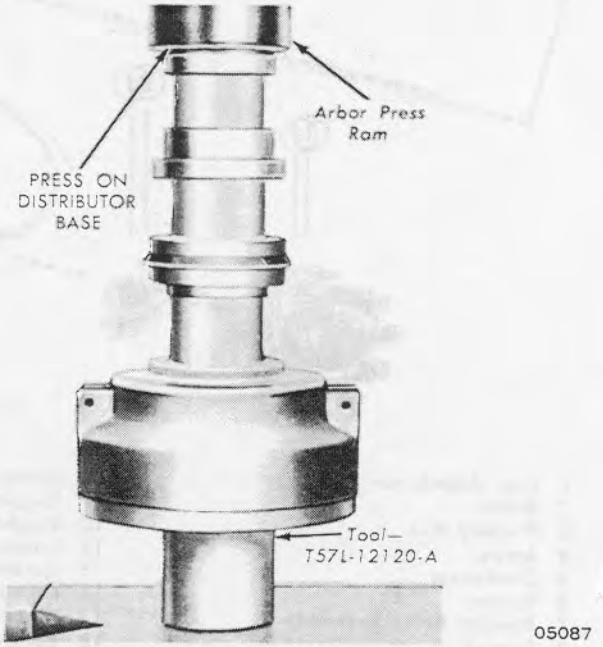


Figure 4. Installing Upper Bushing

8. Remove distributor from press. Install gear retaining pin.
9. Position distributor in a vise. Fill grooves in weight pivot pins with a distributor cam lubricant.
10. Position weights in distributor (marked weight is placed on marked pivot pin) and install weight retainers.
11. Place thrust washer on shaft.
12. Fill grooves in upper portion of distributor shaft with distributor cam lubricant.
13. Install cam assembly. **Be sure that marked spring bracket on cam assembly is near marked spring bracket on stop plate.**
    If a new cam assembly is being installed, make sure that the cam is installed with hypalon covered stop in correct cam plate control slot. This can be done by measuring length of slot used on old cam and by using corresponding slot on new cam. Some cams will have size of slot in degrees stamped near slot. If wrong slot is used, incorrect maximum advance will be obtained.
    Place a light film of distributor cam lubricant on distributor cam lobes. Install retainer and wick. Oil wick with SAE 10W engine oil.
14. Install weight springs. **Be sure that marked spring is attached to marked spring brackets.**
15. Place breaker plate in position.
16. Install breaker plate hold-down screws.
17. Working from inside of distributor, push primary wire thru opening in distributor.
18. Slide diaphragm into opening in distributor and place link in position.
19. Install spring clip, which secures diaphragm link to moveable breaker plate, and install retaining screws.
20. Place breaker point assembly and condenser in position and install retaining screws. Align and adjust breaker point assembly by following procedure for 8-cylinder engines.
21. Connect primary and condenser leads to breaker point assembly.
22. Install rotor and distributor cap.
23. Check and adjust.

NEW SHAFT and GEAR

Shaft and gear are replaced as an assembly. One part should not be replaced without replacing the other. Refer to Figure 1 for placement of parts.

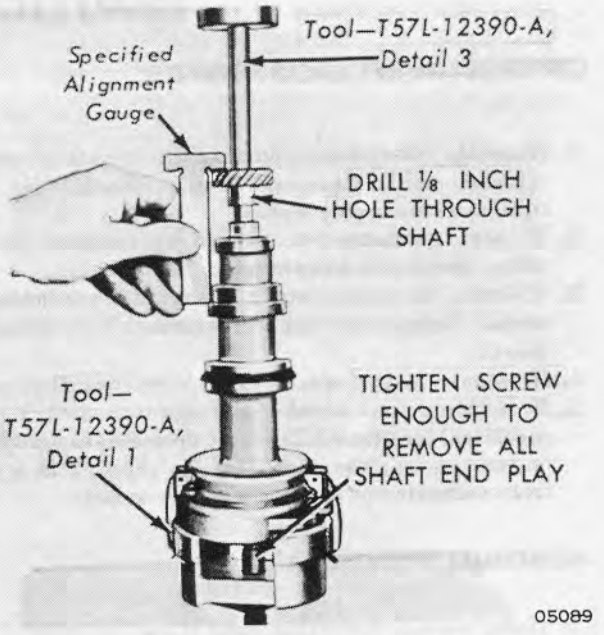


Figure 5. New Shaft and Gear Installation

1. Follow Steps 1, 2 and 3 under "Original Shaft and Gear", preceding.
2. Attach distributor shaft supporting tool to distributor and install assembly in a vise. Insert 0.024" feeler gauge between backing screw and shaft. Tighten backing screw on tool enough to remove all shaft end play. Remove feeler gauge and allow shaft to rest on backing screw. Slide collar on shaft. While holding collar in place against the distributor base, drill 1/8" (3.2mm) hole thru shaft, using access opening in collar as a pilot.
3. Position gear on end of shaft. Install assembly in a press.
4. With backing screw on support tool tightened enough to remove all end play, press gear on shaft to specified distance from bottom face of gear to bottom face of distributor mounting flange. (Figure 5) Drill 1/8" hole thru shaft, using hole in gear as a pilot.
5. Remove distributor from press and remove support tool. Install collar retaining pin and gear retaining pin.
6. Complete assembly by following steps 6-thru 23 under "Reassembly - Original Shaft and Gear", preceding.

ADJUSTING IGNITION POINTS

Refer to "Setting and Alignment of Points", following.

IGNITION CONTACT POINTS

CRITERIA for REPLACING POINTS

1. Examine distributor points. Dirty points should be cleaned with clean point file. Normal point condition is overall grey color.
2. If test instrument for checking resistance is available, check point resistance.
3. Criteria for point quality should be combination of visual inspection and resistance or voltage drop check.
4. Replace badly worn, pitted or misaligned points.
5. If (with points closed and ignition switch in "On" position) less than 0.125 volt drop exists across points, points are satisfactory. Make this check with a sensitive voltmeter or a point resistance meter.

ABNORMAL POINT WEAR

1. Under normal operating conditions, distributor contact points will provide many hundreds-of-hours of service.
2. Points, which have been operated for a period of time, have a rough surface, but this may not mean that points are worn out.
3. If points burn or pit, however, they soon become unsatisfactory for further operation. Not only must they be replaced, but ignition system and engine must be checked to determine cause and elimination of trouble. Unless condition, which causes point burning or pitting. is corrected, new points will provide no better service than old points.

BURNING of POINTS

1. Contact point burning results from high voltage, presence of oil or other foreign material, defective condenser and improper point adjustment.
2. High voltage causes excessively high current flow thru contact points which burns them rapidly. High voltage can result from improperly adjusted or inoperative voltage regulator.
3. Oil or crankcase vapors, which work up into distributor and deposit on point surfaces, cause them to burn rapidly. This is easy to detect, since oil produces a smudgy line under contact points. Clogged engine breather pipes permit crankcase pressure to force oil or vapors up into distributor. Over-oiling distributor also produces the condition.
4. If contact point opening is too small (cam angle too large), points will be closed too large a part of total operating time. Average current flow thru points will be too high, so points will burn rapdily and arcing will occur between points and result in low secondary voltage and engine miss.
5. High series resistance in condenser circuit will prevent normal condenser action, so contact point will burn rapidly. This resistance may be caused by a loose condenser mounting or lead connection, or by poor connections inside condenser. See "Distributor Condenser", following, for a discussion of condenser testing.

PITTING of POINTS

1. Contact point pitting results from an out-of-balance condition in ignition system which causes transfer of tungsten from one point to other so that a tip builds up on one point while a pit forms in other. (Figure 1)

Figure 1. Material Transfer

2. Direction, in which tungsten transfers, can be used as a basis for analysis and correction of pitting. For example, if material transfers from negative to positive point, one or more of these corrections may be made. (Figure 1) Increase condenser capacity, shorten condenser lead, separate distributor-to-coil low and high-tension leads or move these leads closer to ground.
3. If material transfers from positive to negative point (Figure 1), reduce condenser capacity, move distributor-to-coil leads closer together, move these leads away from ground or lengthen condenser lead.

CLEANING of POINTS

1. Dirty contact points should be dressed with a few strokes of a clean, fine-cut contact file. File should not be used on other metals and should not be allowed to become greasy or dirty.

   NOTE: Never use emery cloth to clean contact points.

2. Contact surfaces, after considerable use, may not appear bright and smooth, but this is not necessarily an indication that they are not functioning satisfactorily. Do not attempt to remove all roughness nor dress point surfaces down smooth. Merely remove scale or dirt.
3. Badly burned or pitted contact points should be replaced and cause of trouble determined so that it can be eliminated.

SETTING and ALIGNMENT OF POINTS, 60-80-90, 4 and 6-Cylinder and V-8 (Ford) Engines with Autolite or Mallory Distributors

1. Contact points must be set with a feeler gauge to proper opening. Points set too close may burn and pit rapidly. Points with excessive separation cause a weak spark at high speed.

2. Proper point settings for all models are listed under "Tuneup Specifications", Section 8.
3. New points must be set to larger opening, as rubbing block will wear down slightly while seating to cam.
4. Contact points should be cleaned before adjusting, if they have been in service.
5. To adjust contact point opening:
   a. Turn or crank distributor shaft until breaker arm rubbing block is on extreme top of a lobe of cam which will provide maximum breaker point opening.
   b. Loosen contact support lock screw. (Figure 2)
   c. Use adjusting slots or turn eccentric adjusting screw clockwise or counterclockwise to obtain correct opening for points. See "Tuneup Specifications", Section 8.
   d. Tighten contact support lock screw and recheck point opening.
   e. Align points (Figure 3) by bending fixed contact support, if necessary, then recheck point opening. Do not bend breaker lever. Align new points but do not attempt to align used points. Instead, replace used points where serious misalignment is observed. Use an aligning tool, if available.

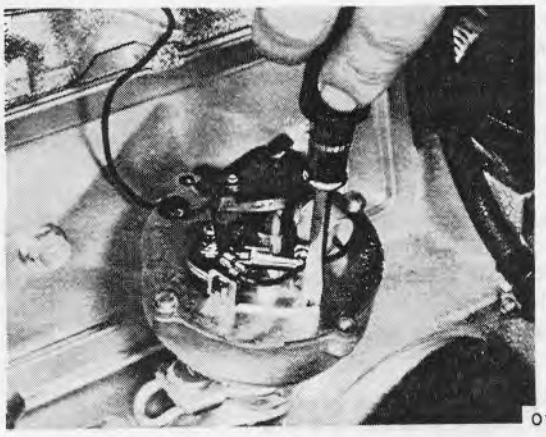


Figure 2. Setting Point Opening

   f. After checking and adjusting contact point opening to specifications, cam angle or dwell may be checked with a contact angle meter, if such equipment is available.

If cam angle is less than specified minimum, check for defective or misaligned contact points or worn distributor cam lobes. Variation in cam angle readings between idle speed and 1750 engine RPM should not exceed 3°. Excessive variation in this speed range indicates wear in distributor.

NOTE: Cam angle readings, taken at speeds above 1750 engine RPM, may prove unreliable on some cam angle meters.

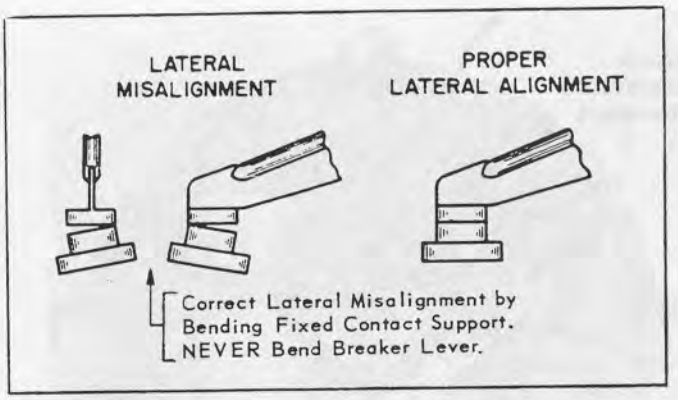


Figure 3. Alignment of Points

ADJUSTING POINTS and DWELL ANGLE - MerCruiser 60, 80 and 90

NOTE: Clean used contact points before adjusting.

1. Loosen contact support lock screw and turn adjusting screw to obtain a .016" (.406mm) gap for MerCruiser "60" and .019" (.483mm) for MerCruiser "80" and "90".
2. Retighten contact support and lock screw. (Figure 1)
3. After checking and adjusting contact point opening to specifications, cam angle or dwell may be checked with a contact angle meter, if such equipment is available. Cam angle should be 56°-60° for MerCruiser "60" and 55° new or 49° used for MerCruiser "80" and "90". If cam angle is less than specified minimum, check for defective or misaligned contact points or worn distributor cam lobes. Variation in cam angle readings between idle speed and 1750 engine RPM should not exceed 3°. Excessive variation in this speed range indicates wear in distributor.

CONTACT POINT REPLACEMENT

4 and 6-Cylinder Distributor

1. Release distributor cap hold-down screws, remove cap and place it out of work area.
2. Remove rotor.
3. Pull primary and condenser lead wires from contact point quick disconnect terminal. (Figure 4)
4. Remove contact set attaching screw and lift contact point set from breaker plate. (Figure 4)
5. Clean oil smudge and dirt from breaker plate.
6. Place new contact point assembly in position on breaker plate and install attaching screw.

CAUTION: Carefully wipe protective film from point set prior to installation.

NOTE: Pilot on contact set must engage matching hole in breaker plate.

7. Connect primary and condenser lead wires to quick disconnect terminal on contact point set.

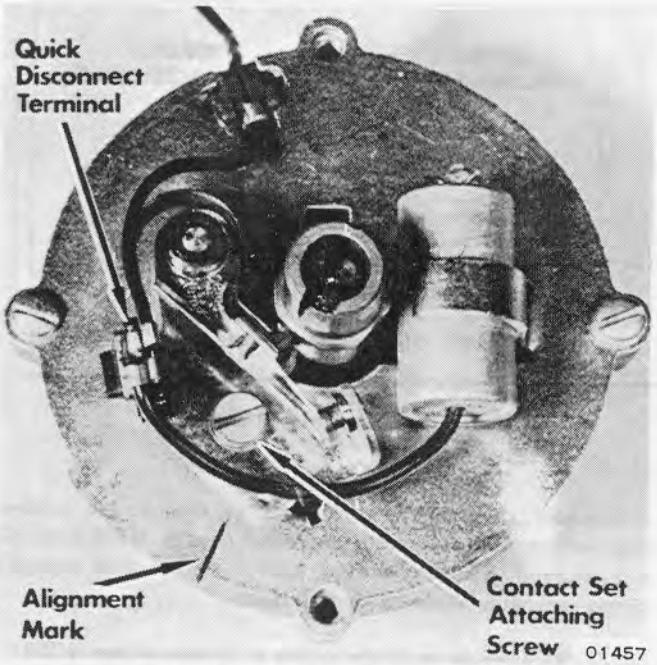


Figure 4. Breaker Plate and Attaching Parts

8. Check and adjust points for proper alignment and breaker arm spring tension. (Figure 5) Use an aligning tool to bend stationary contact support, if points need alignment.

NOTE: Contact point pressure must fall within specified limits. Weak tension will cause chatter which results in arcing and burning of points and an ignition miss at high speed, while excessive tension will cause undue wear of contact points, cam and rubbing block. Breaker arm spring tension should be 19-23 ounces. Contact point pressure should be checked with a spring gauge. Scale should be hooked to breaker lever and pull exerted at 90° to breaker lever as shown in Figure 5. Reading should be taken just as points separate. Pressure can be adjusted by bending breaker lever spring. If pressure is excessive, it can be decreased by pinching spring carefully. To increase pressure, remove lever from distributor so that spring can be bent away from lever. Avoid excessive spring distortion.

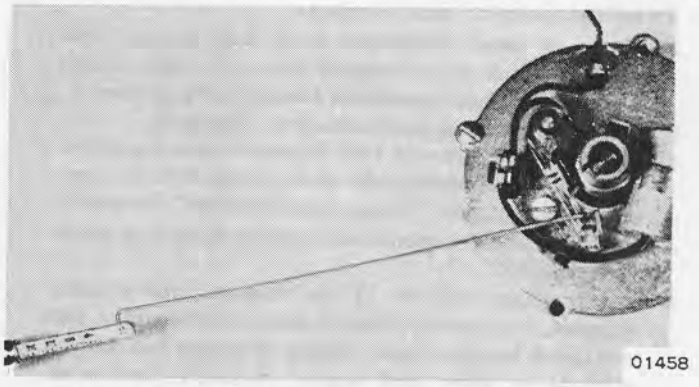


Figure 5. Checking Breaker Arm Spring Tension

9. Set point opening; see "Tuneup Specifications", Section 8.
10. Reinstall rotor and position and lock distributor cap to housing.
11. Check and set ignition timing.

CONTACT POINT REPLACEMENT

8-Cylinder Distributor

1. Contact point set is replaced as one complete assembly and only dwell angle requires adjustment after replacement. Breaker lever spring tension and point alignment are factory set.
2. Remove distributor cap by placing a screwdriver in slot head of latch, press down and turn 1/4-turn in either direction.
3. Remove 2 attaching screws (Figure 6) which hold base of contact set assembly in place.
4. Remove primary and condenser leads from their nylon insulated connection by turning screw (Figure 6) in contact set.
5. Reverse Steps 3 and 4 to install new contact set.

CAUTION: Install primary and condenser leads as shown in Figure 6. Improper installation will cause lead interference between cap, weight base and breaker advance plate.

6. If engine has 250 hours, cam lubricator wick (Figure 6) should be changed. Squeeze assembly together at base with long-nosed pliers and lift out. Remove all old lubricant from cam surface. Replace in same manner.

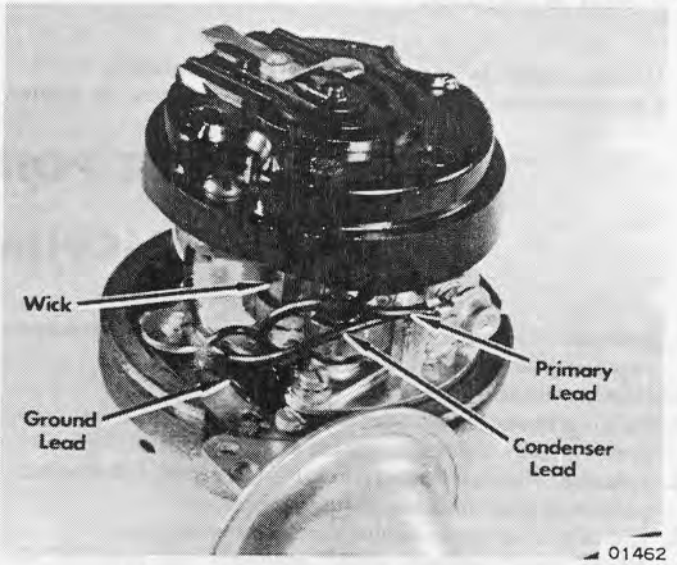


Figure 6. Distributor Lead Arrangement

NOTE: Distributors equipped with cam lubricator should have wick replaced at same time contact point set is replaced. End of cam lubricant wick should be adjusted to just touch cam lobes. Over-lubrication of cam, resulting in grease on contact points, can be caused by cam lubrication wick bearing too hard against cam surface. A correctly-adjusted cam lubricator wick will provide adequate lubrication for cam. Do not apply additional grease to cam surface.

ADJUSTING DWELL ANGLE

8-Cylinder Distributor

1. To adjust dwell angle (contact point opening), run engine at idle and raise window provided in distributor cap.
2. Insert a hex type wrench into head of adjusting screw, as shown in Figure 7.
3. Either of 2 methods may be used to set dwell angle:
   a. Turn adjusting screw until specified dwell angle of 28° to 32° (with 30° perferred) is obtained, as measured by a dwell meter.
   b. Turn adjusting screw in (clockwise) until engine begins to miss, then turn ½-turn in opposite direction. (This method is used only when dwell meter is not available.)
4. Since contact point set is factory aligned on assembly, dwell angle is only necessary adjustment.
   a. Correct contact point opening is important, especially during starting and low speed operation. If contact points are set too close, arcing and burning will occur, thus causing hard starting and poor low speed performance. If points are set too wide, cam angle or dwell will be too small to allow saturation of coil at high engine speeds and will result in a weak spark. Distributor point opening has a direct bearing on cam angle or dwell, which is the number of degrees that breaker cam rotates from time points close until they open again.
   b. Replace points which are burned or badly pitted. FIND CAUSE OF TROUBLE. Where burned or badly pitted points are encountered, ignition system and engine should be checked by a servicing dealer to determine cause of trouble so that it can be eliminated. Unless condition, which causes point burning or pitting is corrected, new points will provide no better service than old points.

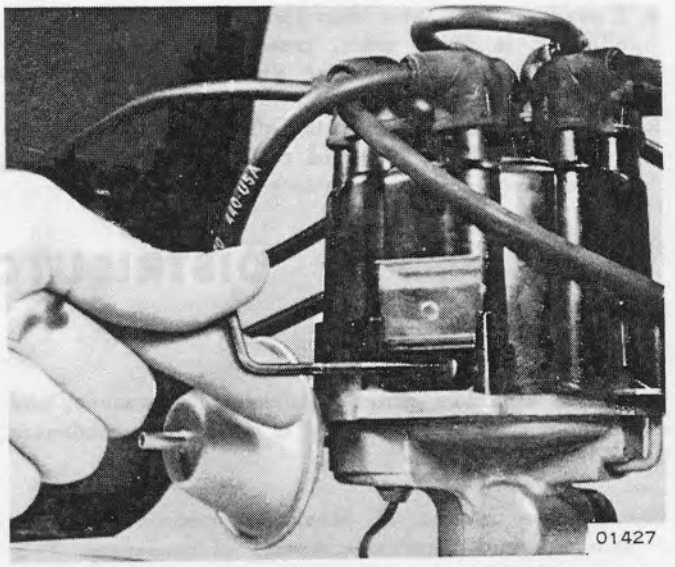


Figure 7. Setting Dwell Angle - 8-Cylinder Distributor

COIL and RESISTOR CHECKS

SECONDARY RESISTANCE and POLARITY

1. Use Magneto Analyzer (C-91-25213).
2. Uniform normal readings, as specified by manufacturer, indicate all secondary circuit components are in good condition.
3. If all readings are below normal, check for corroded coil tower terminal, poorly connected or broken coil wire, center cap electrode or rotor tip burned or an open secondary in coil.
4. If readings are higher than normal at 2 or more plugs adjacent in firing order, cross-fire is occurring in distributor cap or between spark plug cables concerned.
5. If meter reads off scale to left, coil polarity is reversed. Check for reversed coil primary wires, wrong coil or reversed vehicle battery connections.

IGNITION OUTPUT and SECONDARY LINKAGE

1. Use Magneto Analyzer (C-91-25213).
2. GOOD readings indicate both ignition output and secondary insulation are good.
3. If all readings are BAD, or if ignition test calibrator cannot be adjusted to set line, check for high resistance in primary circuit, defective distributor points, coil or condenser.
4. If readings are BAD when certain plug wires are lifted off, check for cracks or carbon tracks in distributor cap or defective insulation on those plug wires being lifted off.

DISTRIBUTOR CONDENSER

PERFORMANCE

Following 4 factors affect condenser performance, and each factor must be considered in making any condenser test.

Breakdown--a failure of insulating material--a direct short between metallic elements of condenser. This prevents any condenser action.

Low Insulation Resistance (Leakage)--prevents condenser from holding a charge. All condensers are subject to leakage which, up to a certain limit, is not objectionable.

High Series Resistance--excessive resistance in condenser circuit due to broken strands in condenser lead or to defective connections. This will cause burned points and ignition failure upon initial start and at high speeds.

Capacity--determined by area of metallic elements and insulating and impregnating materials.

For a complete check of condenser, use a tester which will check above conditions. Follow instructions given by manufacturer of test equipment.

Condenser capacity should be .18-.23 microfarad.

SPARK PLUGS

INSPECTION

1. Inspect each plug individually every 100 hours for badly worn electrodes, glazed, broken or blistered porcelain and replace where necessary.

   NOTE: Spark plugs should be replaced after 200 hours of operation.

2. Inspect each spark plug for make and heat range. All plugs must be the same make and number or heat range. Refer to "Specifications", Section 8, for spark plug numbers.

CAUTION: Never bend the center electrode to adjust gap. Always adjust by bending ground or side electrode.

3. Adjust spark plug gaps with a round feeler gauge. Refer to "Specifications", Section 8, for spark plug gap. (Figure 1) Replace defective plugs.
4. Install spark plugs to engine with new gaskets and torque as specified in "Specifications" section.

   NOTE: Improper installation is one of the greatest single causes of unsatisfactory spark plug performance.

5. Always use a new gasket and wipe seats in head clean. Gasket must be fully compressed on clean seats to complete heat transfer and provide a gas tight seal in cylinder. For this reason, as well as necessity of maintaining correct plug gap, correct torque is very important during installation.
6. Replace or repair any loose or damaged spark plug wires. Install all wires to proper spark plug. Proper positioning of spark plug wires in supports is important to prevent cross-firing.

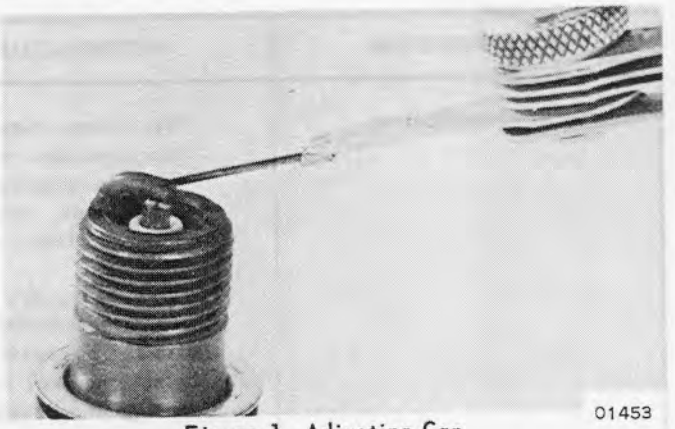

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Figure 1. Adjusting Gap

SPARK PLUG INTERCHANGEABILITY

AC resistor-type spark plugs CR44N or CR43N are used on latest production MerCruiser 120-140-160-200 Engines. They are interchangeable with C44N or C43N spark plugs. As a service item, CR44N or CR43N plugs can be used on previously produced MerCruiser 110-120-140(6-Cyl.)-160-200. Tapered seat spark plugs are not interchangeable with nontapered (with gasket) spark plugs. Refer to "Specifications" Section 8 for recommendations.

SPARK PLUG DIAGNOSIS

PLUG CONDITIONS	FACTORS CAUSING THIS CONDITION	CORRECTIVE ACTION
Plug "Flash Over" (firing from upper terminal to base of plug)	Dirty insulator tops--oil dirt and moisture on insulator will shunt current to base of plug. The above condition can be caused by failure of spark plug boot.	Keep plugs wiped clean with cloth moistened with cleaning solvent. Check spark plug boot and replace if necessary.
Lead Fouling (light and powdery or shiny glazed coating on firing end)	By-products of combustion and fuel additives, deposited as a powder which may later melt and glaze on insulator tip.	Remove deposits by blast cleaning. If this is not possible, plugs should be replaced.
Damaged Shell	Very seldom occurs, but cause is almost always due to mishandling by applying excessive torque during installation. This failure is usually in the form of a crack in the Vee of the thread next to the seat gasket or at the groove below the hex.	Replace with a new spark plug.

SPARK PLUG DIAGNOSIS (CONTINUED)

PLUG CONDITIONS	FACTORS CAUSING THIS CONDITION	CORRECTIVE ACTION
Oil or Carbon Fouling	Wet, black deposits on firing end of plug indicate oil pumping condition. This is usually caused by worn piston rings, pistons, cylinders or sticky valves.	Correct engine condition. In most cases, plugs in this condition will be serviceable after proper cleaning and regapping.
	Soft, fluffy, dry black carbon deposits usually indicate a rich mixture operation, excessive idling, improper operation of automatic choke or faulty adjustment of carburetor.	If troubles are not eliminated, use "hotter" type plug.
	Hard, baked-on, black carbon deposits result from use of too cold a plug.	Use "hotter" type plug.
Normal Electrode Wear	Due to intense heat, pressure and corrosive gases together with spark discharge, the electrode wears and gap widens.	Plugs should be regapped every 100 hours.
Rapid Electrode Wear	Condition may be caused by (1) burned valves, (2) gas leakage past threads and seat gaskets, due to insufficient installation torque or damaged gasket, (3) too lean a mixture or (4) plug too "hot" for operating speeds and loads.	Correct engine condition. Install plugs to specified torque. Use a new spark plug seat gasket each time a new or cleaned spark plug is installed. Use "colder" type plug if condition continues to exist.
Broken Upper Insulator (Firing around shell crimp under load conditions)	Careless removal or installation of spark plug.	Replace with a new spark plug.
Broken Lower Insulator (Firing Tip)	The cause is usually carelessness in regapping by either bending of centerwire to adjust the gap or permitting the gapping tool to exert pressure against the tip of the center electrode or insulator when bending the side electrode to adjust the gap.	Replace with a new spark plug.
	Fracture of breakage of lower insulator also may occur occasionally if the engine has been operated under conditions causing severe and prolonged detonation or pre-ignition.	Use "colder" type plug for the particular type of operation.

BATTERY

Refer to "Starting Systems" in this section.

BREAKER POINT IGNITION TIMING

TIMING MARK LOCATION

The timing marks and their locations are illustrated in Figures 1-thru-7.

TIMING MERCRUISER ENGINES (Except 60-80-90)

1. Connect timing light to No. 1 spark plug, using extension at plug. Connect power supply leads on light to battery (12 volts). Refer to "Specifications", Section 8, for cylinder numbering and location.
2. Connect tachometer to engine.
3. Start engine and run at 500 RPM.
4. Aim timing light at timing tab, located on timing gear cover and crankshaft pulley on "110" or harmonic balancer on "140" and "V-8" engines.

NOTE: Early production "110" and "140" engines have timing tab located at right (starboard) side of timing gear cover and timing notch on outer edge of crankshaft pulley or harmonic balancer. (Figures 1 and 2)

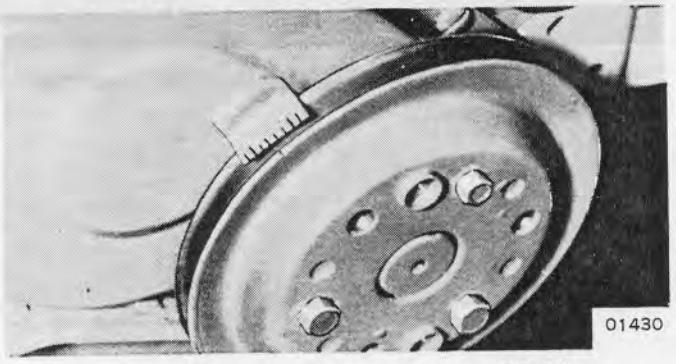

Figure 1. Early Timing Tab on "110"

Late production "110" and "140" engines have timing tab located on left (port) side of timing gear cover and timing notch on inner edge of crankshaft pulley or harmonic balancer. (Figure 3)

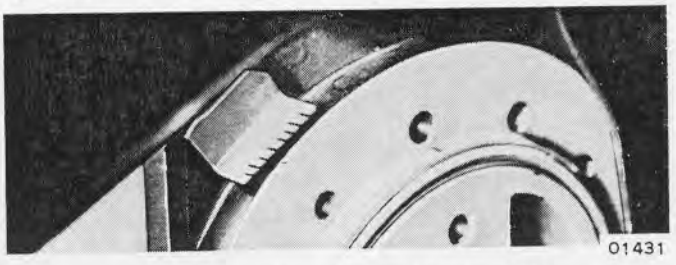

Figure 2. Early Timing Tab on "140"

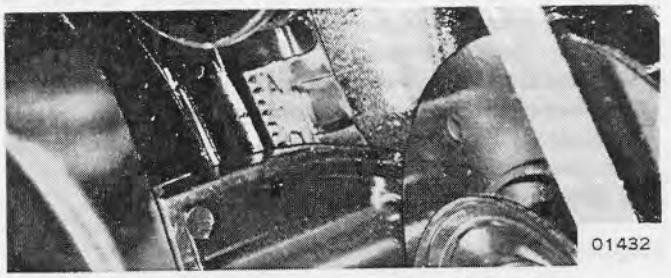

Figure 3. Late Timing Tab on 4 & 6 Cylinder

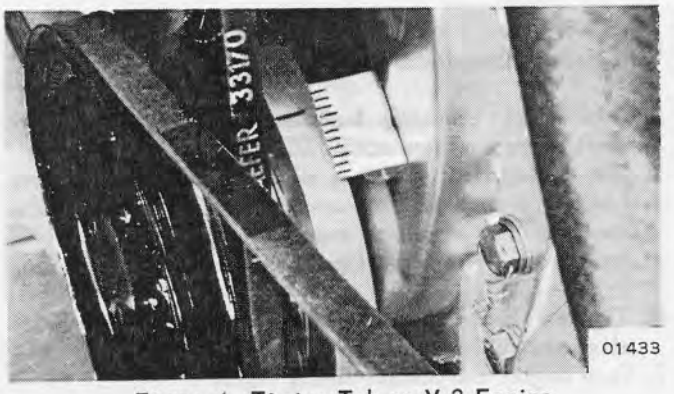

Figure 4. Timing Tab on V-8 Engine

Markings on tabs are in 2° increments, with greatest number of markings on "A" side of "O". All BTDC settings fall on the "A" (Advance) side of "O".

5. Adjust timing by loosening distributor clamp and rotating distributor body as required until timing mark on balancer or pulley lines up with mark on tab specified in "Specifications", Section 8. Tighten clamp and recheck location of timing mark.
6. Stop engine and remove timing light.

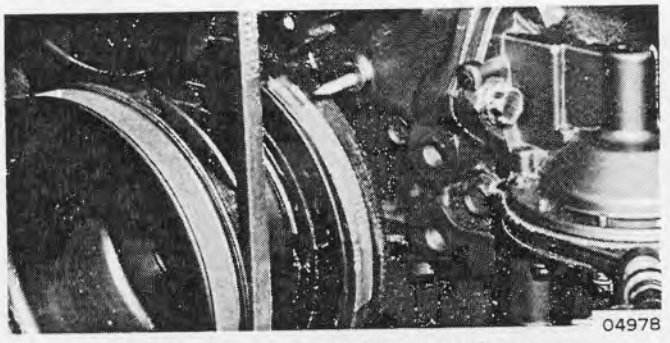

Figure 5. Timing Line on "888-215-225II-TR and 255II-TR" Engines

TIMING MERCRUISER 60, 80, and 90

ENGINE NOT RUNNING

1. Locate No. 1 piston in firing position by either of 2 methods described below.
   a. Remove No. 1 spark plug and, with finger on plug hole, crank engine until compression is felt in No. 1 cylinder. Continue cranking until mark on timing chain cover lines up with timing mark on alternator flywheel, or . . . . . .
   b. Remove rocker cover and crank engine until No. 1 intake valve closes, then continue to crank slowly until mark on timing chain cover lines up with timing mark on alternator flywheel. (Figure 6)

NOTE: No. 1 cylinder is cylinder nearest transom.

2. Connect 12-volt test lamp or voltmeter between is tributor primary lead screw and to ground.
3. Turn on ignition switch.
4. Loosen distributor hold-down clamp and turn distributor counterclockwise until test lamp lights or voltmeter indicates 12 volts. This indicates that contact points are just opening.
5. Tighten distributor hold-down clamp.

ENGINE RUNNING

1. Connect timing light to No. 1 spark plug.

NOTE: No. 1 cylinder is cylinder nearest transom. Refer to "Specifications", Section 8.

2. Connect power supply leads on timing light to battery.
3. Start engine and run at 650 RPM.
4. Aim timing light at timing mark on timing chain cover.
5. Loosen distributor hold-down clamp and turn distributor in either direction required until timing mark on alternator flywheel aligns with mark on housing. (Figure 7)
6. Tighten distributor hold-down clamp and recheck alignment of timing marks.
7. Stop engine and remove timing light.

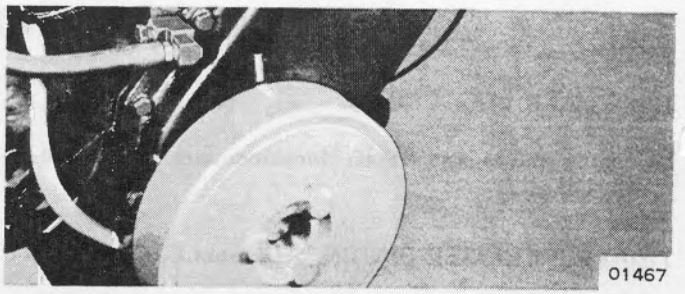

Figure 6. Timing Tab on MerCruiser "60"

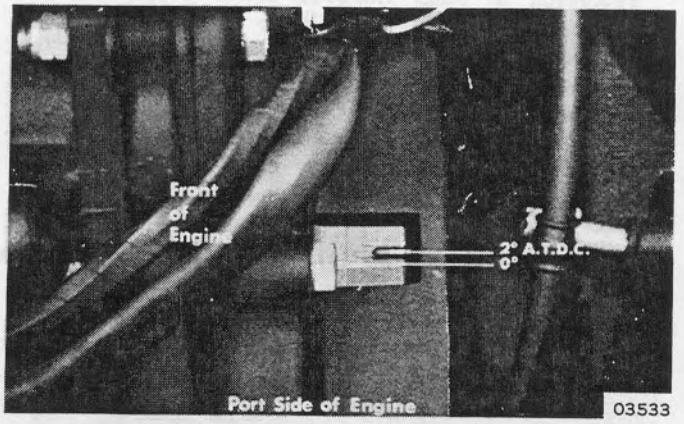

Figure 7. Lining-Up Timing Marks - "80" and "90"

THUNDERBOLT IGNITION

DESCRIPTION

Thunderbolt Ignition is a capacitance discharge breakerless system. A rotating metal disc replaces conventional breaker points. The system developes up to 40,000 volts to the spark plugs.

COMPONENTS

The Thunderbolt Ignition System consists of a trigger assembly, which replaces the distributor, on ignition coil assembly, a switch box assembly and Polar-Gap spark plugs.

PRECAUTIONS

WARNING: When testing or servicing the ignition system, it is of extreme importance that the following precaution is observed, as high voltage is present. DO NOT touch or disconnect any ignition system parts while engine is running, key switch is on, or while battery cables are connected.

Failure to comply with the following items may result in damage to the ignition system.

- Do not reverse battery cable connections at the battery. System is negative (-) ground.
- Do not "spark" battery terminals with battery cable connectors to check polarity.
- Do not disconnect battery cables while engine is running.
- Use only test equipment as specified. System cannot be checked with conventional ignition test equipment.
- Follow service procedures in the order they are listed in the following information.

THUNDERBOLT IGNITION CHECKS

CHECKING THUNDERBOLT IGNITION SYSTEM

Use process of elimination when checking ignition system, as component parts of system cannot be checked with type of test equipment used on conventional ignition systems. Following parts are required to check system:

1. Trigger assembly
2. Ignition coil assembly
3. Switch box assembly
4. Voltmeter (capable of reading 0-15 volts or more).
5. Short jumper lead and an ohmmeter also are required.

CHECKING SPARK PLUGS

1. Remove spark plugs from cylinder heads.

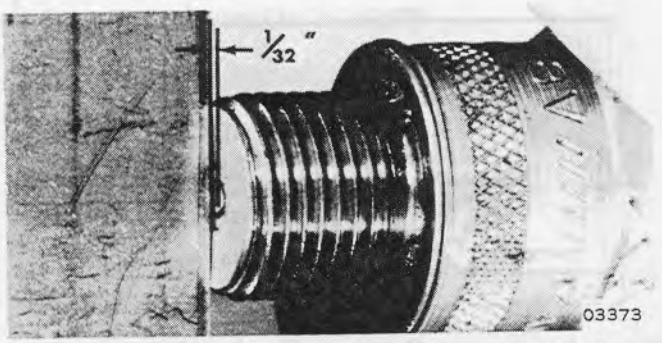

Figure 1. Checking Spark Plug Electrode Depth

2. Check condition of external insulator. If insulator is cracked, replace plug.
3. Check depth of center electrode as shown in Figure 1. If electrode is burned back more than 1/32" (.8mm), replace plug.
4. Cracks, which may be found around internal insulator (electrode end), will not harm plug operation, and plug may be used.

CHECKING for SPARK at SPARK PLUG LEAD

1. Remove any one spark plug lead from spark plug.
2. Remove ground electrode from a standard type spark plug (not Polar-Gap) and connect plug to spark plug lead and ground on engine. (Figure 2)

WARNING: High voltage is present. DO NOT hold spark plug in hand when making this check.

3. Turn engine over with starter and watch for spark across plug. If no spark is observed, proceed with following check.

NOTE: If one or more cylinders are not firing properly or "missing", perform preceding check on all spark plug leads.

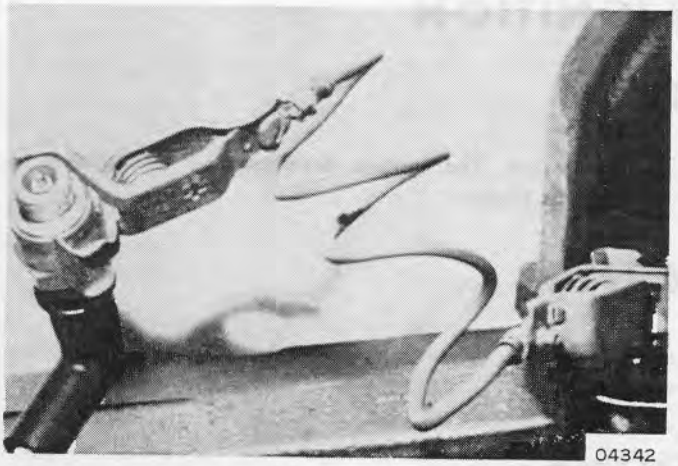

Figure 2. Checking for Spark at Spark Plug Lead

CHECKING for SPARK at COIL

1. Remove secondary coil lead from distributor and position end of lead 1/2" (12.7mm) from ground. (Figure 3)

> **WARNING:** High voltage is present. Do not hold lead wire in hand when making this check.

2. Turn engine over with starter and watch for spark across air gap between lead and ground.
   a. If spark is observed across air gap, cause for no spark in preceding "Checking for Spark at Spark Plug Lead" is in secondary section of distributor.

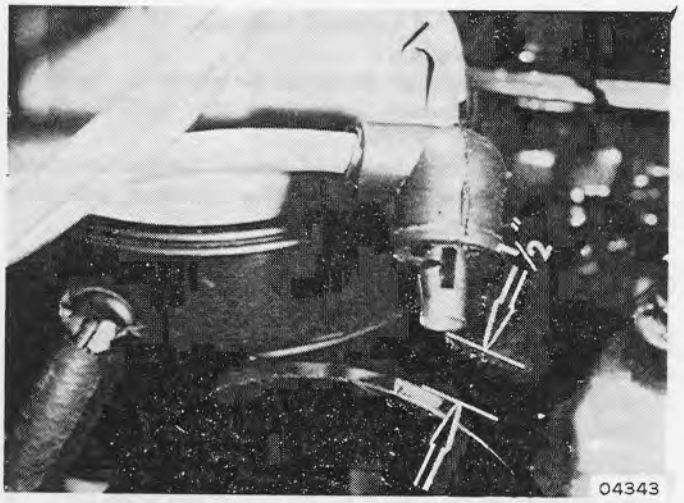

Figure 3. Checking for Spark at Coil

   Remove distributor cap and check rotor, inside of cap and lead wires. Replace damaged, worn or unservicable parts.

   b. If no spark is observed across air gap, proceed with following check.

WIRING and CONNECTIONS

1. Connect positive voltmeter lead to terminal on switch box which has red wire connected to it. Connect negative voltmeter lead to ground on engine. (Figure 4)
2. With key switch in "OFF" position, observe voltmeter.
   a. Meter should indicate battery voltage. If meter reading is below battery voltage, or no voltage is indicated, check red wire with ohmmeter for an open circuit or high resistance. (Figure 5)
   b. If meter indicates battery voltage, proceed with next step.
3. Remove positive voltmeter lead from red terminal on switch box and connect it to terminal which has white wire connected to it. (Figure 4)

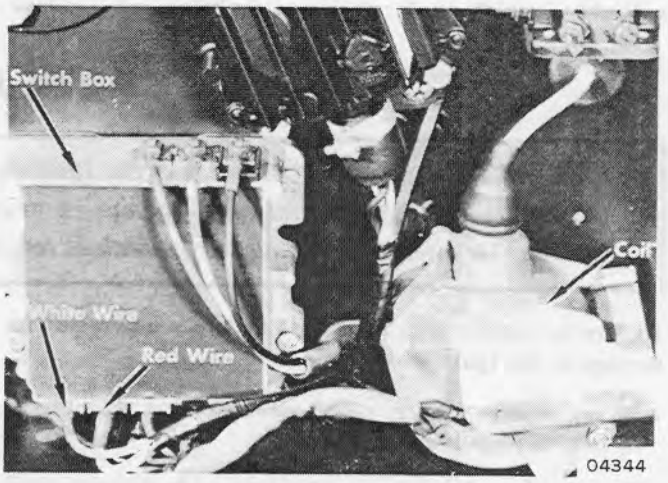

Figure 4. Voltmeter Connections

4. With key switch in "ON" position, observe voltmeter.
   a. Meter should indicate battery voltage. If meter reading is below battery voltage, or no voltage is indicated, check white wire, key switch and wiring to key switch with ohmmeter for an open circuit or high resistance. (Figure 5)
   b. If meter indicates battery voltage, disconnect volt meter, turn key to "OFF" and proceed with following check.

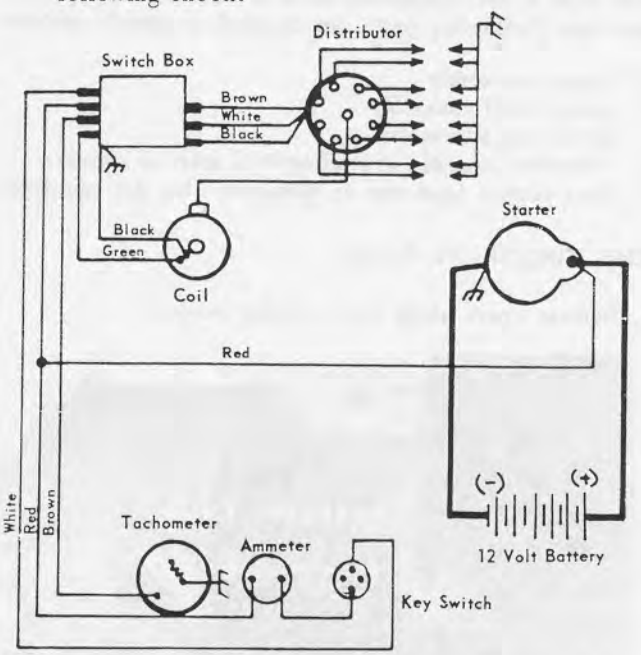

Figure 5. Schematic Diagram - Thunderbolt Ignition System

DISTRIBUTOR TRIGGER, SWITCH BOX and COIL

1. Remove brown, white and black trigger leads from switch box and connect brown, white and black leads from new trigger to switch box. Connect jumper lead from trigger housing to ground. (Figure 6)
2. Position secondary coil lead as outlined under "Checking for Spark at Coil", Step 1, preceding.
3. Turn key switch to "ON" position and pass a metal object (feeler gauge, nail file, etc) back and forth between trigger inductance coils while, at same time, observing air gap between coil lead and ground. (Figure 6)
   a. If spark is observed across air gap, original trigger is not functioning and should be replaced as outlined under "Thunderbolt Ignition Service, following.
   b. If no spark is observed, and a "click"-like noise emits from ignition coil, coil is shorted and should be replaced.
   c. If no spark is observed and coil click is not heard, remove test trigger and proceed as follows.
4. Remove wires from switch box and install new switch box.
5. Connect all wires and repeat "Checking for Spark at Spark Plug Lead", preceding. If no spark is observed, install original switch box and replace ignition coil.

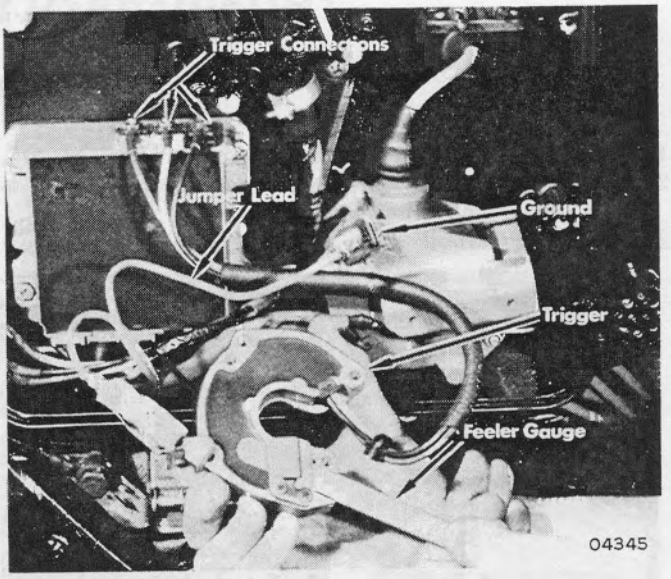

Figure 6. Checking Trigger

THUNDERBOLT IGNITION SERVICE

REMOVAL

1. Disconnect positive (+) battery cable from battery.
2. Remove screws, which fasten electrical panel cover to panel, and remove cover.
3. Disconnect brown, white and black trigger leads from

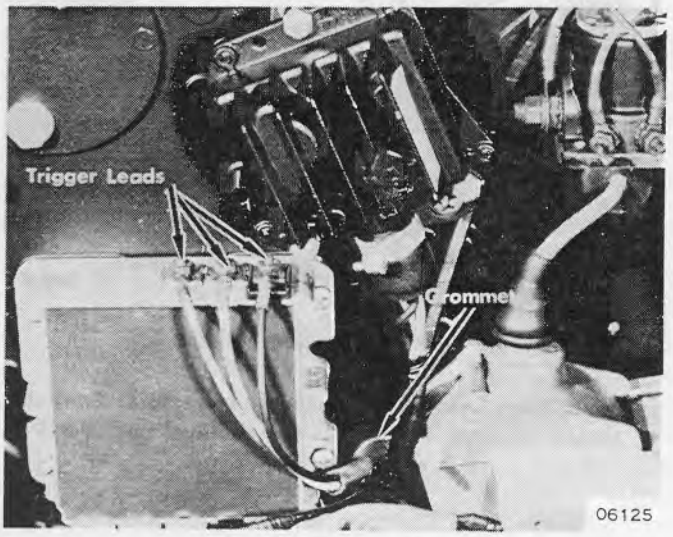

Figure 7. Trigger Leads

terminals located on switch box. (Figure 7) Pull leads thru grommet out of electrical panel.

4. Place a mark on distributor adaptor housing adjacent to No. 1 cylinder distributor cap tower. (Figure 8)

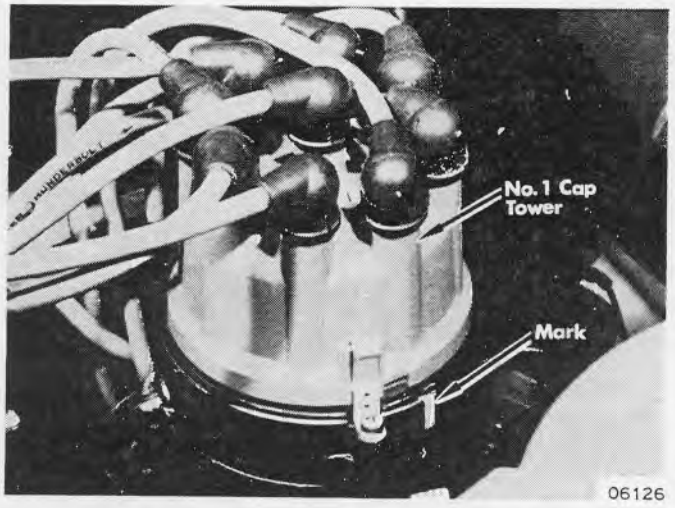

Figure 8. Marking Adaptor Housing

5. Loosen distributor cap retaining screws and remove distributor cap.
6. Rotate crankshaft (in normal direction of rotation)

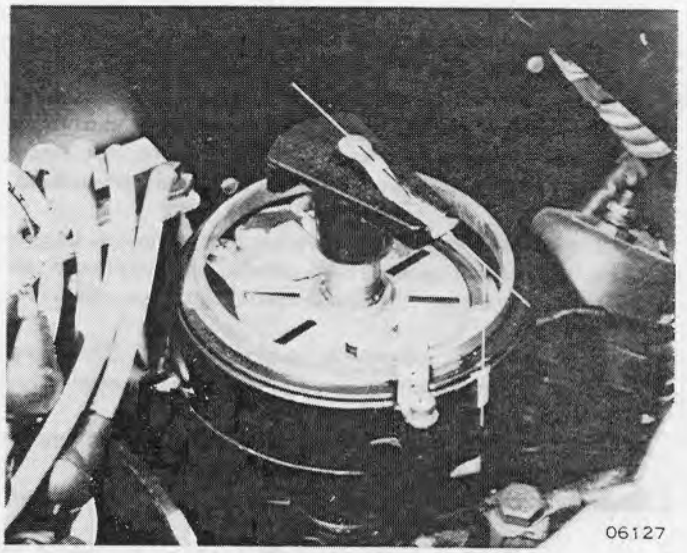

Figure 9. Rotor Aligned with Mark

until distributor rotor lines up with mark on adaptor housing (Figure 9) and timing mark, which is located on torsional damper, is in line with top dead center mark located on timing tab. (Figure 10)

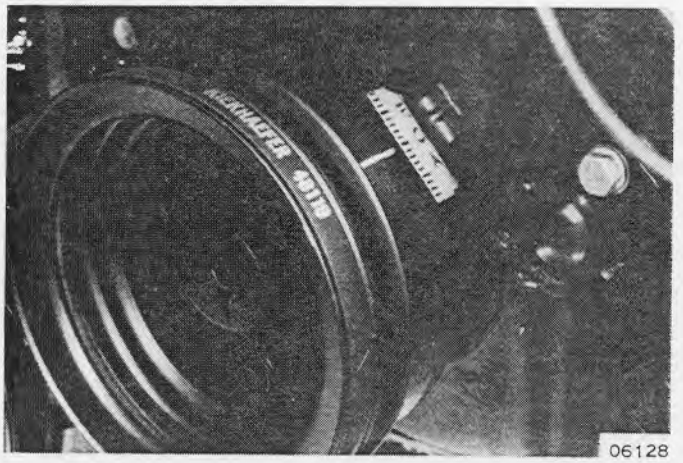

Figure 10. Timing Marks Aligned - Top Dead Center

7. Remove screw which fastens distributor ground wire to intake manifold.

NOTE: No. 1 cylinder now is positioned at top dead center of its compression stroke.

8. Remove distributor hold-down screw and clamp and lift distributor up out of engine. Remove distributor pilot to intake manifold gasket.

DISASSEMBLY

1. Place a mark on adaptor housing and distributor pilot to aid in reassembly. (Figure 11)
2. Remove rotor from distributor shaft by pulling rotor straight up.

NOTE: If rotor is not damaged or worn, and replacement is not required, do not remove it from shaft. Loctite (C-92-32609) is used to retain rotor to shaft.

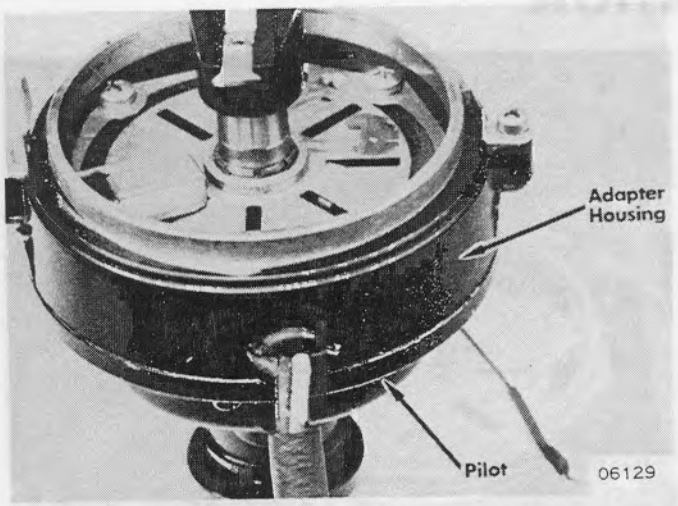

Figure 11 . Adaptor Housing and Pilot

Be careful when removing, so that distributor shaft does not bend nor that slotted disc becomes damaged.

3. Remove 4 screws and lockwashers, which fasten adaptor housing to pilot, and remove adaptor housing.
4. Remove 4 screws and lockwashers, which fasten trigger assembly to pilot, and remove trigger. (Figure 12)
5. Support gear in a suitable fixture and drive pin out of gear and shaft. Remove gear from shaft.

This completes disassembly of distributor. Further disassembly of pilot and shaft assembly is not recommended, as special fixtures are required to reassemble. Also, individual parts for servicing pilot and shaft assembly are not available.

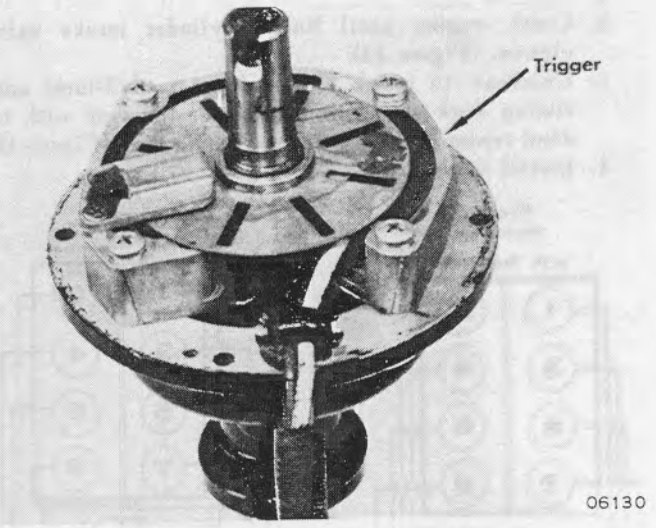

Figure 12. Trigger Assembly

REASSEMBLY

1. Place gear on shaft, indexing alignment notch and mark on gear as shown in Figure 13. Support gear in a suitable fixture and install new roll pin.
2. Place trigger assembly in position on pilot and fasten trigger to pilot with 4 screws and lockwashers. (Figure 13)
3. Place adaptor housing in position on pilot and fasten adaptor housing to pilot with 4 screws and lockwashers (Figure 11)
4. Apply 4 drops of Loctite "A" (C-92-32609) to inside of rotor and place rotor on shaft.

Figure 13. Distributor Gear and Shaft Indexing

INSTALLATION

1. Prior to installing distributor, No. 1 piston must be positioned at top dead center of its compression stroke.

   If piston position has been disturbed since performing Step 6, listed under "Removal", proceed as follows:

   a. Remove rocker arm cover from left cylinder head.
   b. Crank engine until No. 1 cylinder intake valve closes. (Figure 14)
   c. Continue to crank slowly (approx. 1/3-turn) until timing mark on torsional damper lines up with top dead center mark (located on timing tab). (Figure 10)
   d. Install valve cover.

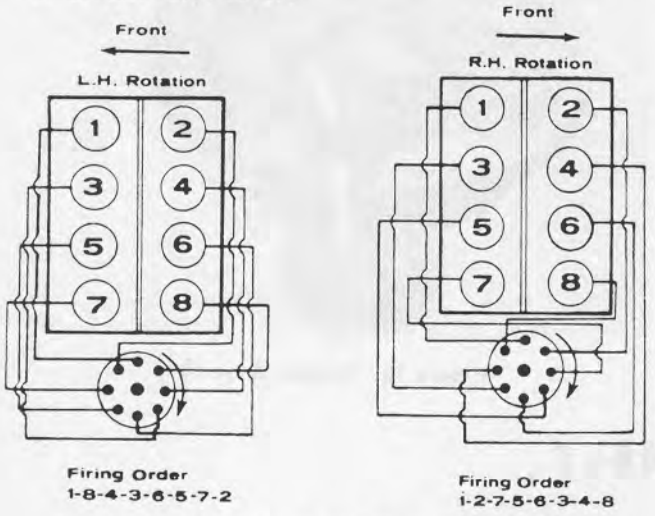

Figure 14. Cylinder Location and Firing Order

2. Place new gasket on distributor pilot.
3. Position distributor pilot in cylinder block so that mark on adaptor housing is toward front of engine.
4. Position rotor in line with mark on adaptor housing.
5. Turn rotor, as required, to engage distributor gear and camshaft gear so that rotor points toward front of engine.

   NOTE: With No. 1 piston at top dead center of its compression stroke (timing marks aligned), rotor must point toward front of engine when distributor is down in position. It may be necessary to turn engine over with starter, while pressing down on distributor pilot, to engage oil pump shaft.

6. Turn distributor pilot, as required, to line up mark on adaptor with rotor. (Figure 15)
7. Install hold-down clamp and screw.
8. Connect ground wire to intake manifold.
9. Feed trigger leads thru grommet in electrical panel and connect leads to switch box, matching color-to-color.
10. Install distributor cap.
11. Install electrical panel cover.
12. Connect timing light to No. 1 cylinder spark plug and lead wire.
13. Start engine and run at 550-600 RPM.
14. Aim timing light at timing tab.
15. Adjust timing by loosening distributor clamp and rotating distributor, as required, to align timing marks as shown in Figure 16 or 17.

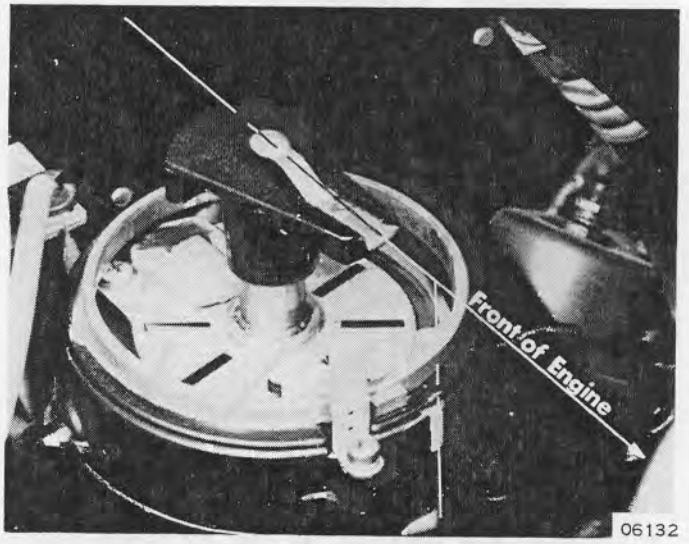

Figure 15. Distributor Rotor and Pilot Position

16. Tighten clamp screw and recheck timing marks.
17. Stop engine and remove timing light.

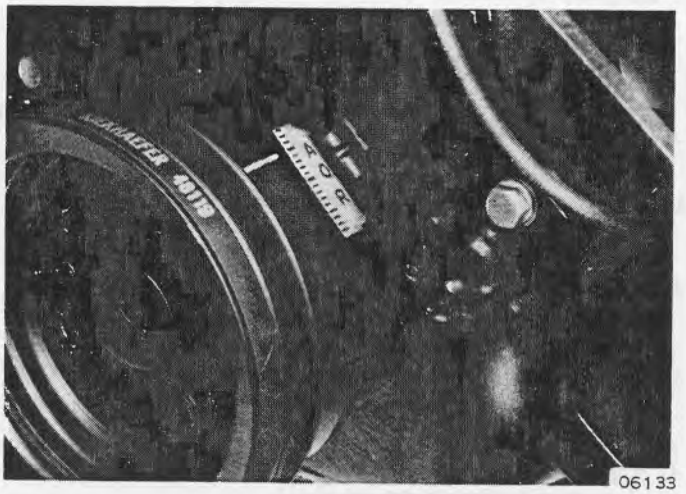

Figure 16. Timing Marks Aligned - 10° BTDC - Left Hand Rotation Engine

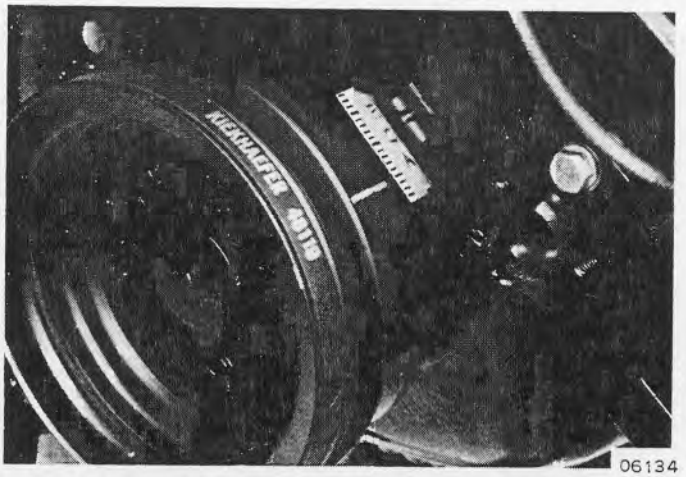

Figure 17. Timing Marks Aligned - 10° BTDC - Right Hand Rotation Engine

MALLORY DISTRIBUTOR

INSPECTION (Distributor in Engine)

1. Remove distributor cap. Clean and inspect for cracks, carbon tracks and burned-out or corroded terminals. Replace cap if necessary.
2. Make sure that all distributor wire terminals are clean and tight.
3. Clean rotor and inspect for damage or deterioration. Replace rotor if necessary.
4. Inspect breaker assembly for damage, wear, dirty or badly pitted points. Replace if necessary. See "Ignition Contact Points", preceding.
5. Test condenser for series resistance, microfarad capacity and leakage or breakdown, following instructions given by manufacturer of test equipment used. (Refer to Section 8 for specifications.)
6. Check distributor bushings for wear. Attach dial indicator to distributor housing. Position registering point of dial indicator to rest on distributor shaft. Shaft must not have more than .002" side play within bushings when shaft is pushed back-and-forth by hand.
7. Check for sticking centrifugal weights. Grip distributor shaft (or rotor) and twist in direction of rotation, then release. Shaft should snap back to its original position. If it hangs up, returns sluggishly or slowly, distributor must be replaced.

LUBRICATION

1. Apply a light film of suitable high-melting-point, non-bleeding grease on distributor cam surface. Repeat every 50 hours of operation or once every year.
2. Add 5 to 7 drops of engine oil in oiler tube for bushing lubrication every 50 hours of operation or once every year.

ADJUSTING IGNITION POINTS

Refer to "Setting and Alignment of Points", preceding.

REMOVAL

1. Remove distributor cap (2 screws) and gasket. Do not remove plug wires from cap.
2. Disconnect coil primary lead from distributor.
3. Crank or turn engine slowly. Align timing marks when rotor is pointing to No. 1 terminal of distributor cap. If same distributor is to be reinstalled in engine, mark position of distributor housing in relation to engine so that distributor may be installed in same position.
4. Remove distributor retaining clamp (one screw).
5. Remove distributor.

NOTE: To simplify distributor installation. DO NOT turn crankshaft with distributor removed from engine.

DISASSEMBLY

IMPORTANT: DO NOT disassemble distributor if not necessary, as oil seal may be damaged. When checking for worn parts, refer to "Inspection (Distributor in Engine)", preceding.

1. If not previously removed, remove distributor cap (2 screws) and distributor cap gasket.
2. Lift rotor off distributor shaft.
3. Disconnect condenser lead from primary terminal and remove retaining screw, bracket and condenser.
4. Disconnect breaker assembly lead from primary terminal and remove retaining screw and breaker assembly.
5. Mark breaker plate location and remove plate retaining screws and plate. Be careful not to lose distributor identification plate.
6. Remove oiler stem and wick from distributor housing. (Oiler stem is a press fit into housing.)
7. Drive pin from drive gear and remove gear from shaft.
8. Drive roll pin from distributor shaft collar and remove collar, washer, distributor housing and washer.
9. Remove vent screen from housing.

CLEANING and INSPECTION (Distributor Disassembled)

1. Wash all parts in cleaning solvent, except cap, rotor, condenser and breaker assembly. Degreasing compounds may damage insulation of these parts or saturate lubricating felt in breaker assembly.
2. Inspect breaker assembly for damage, wear, dirty or badly pitted points. Replace if necessary. (See "Ignition Contact Points", preceding.)
3. Check shaft fit in bushings in distributor body. If shaft or bushings are worn, replace distributor.
4. Inspect advance weights for wear or burrs and free fit on their pins. If worn, replace distributor.
5. Inspect cam for wear or roughness. Check cam fit on end of shaft. It should be free, but not loose. If worn, replace distributor.
6. Test condenser for series resistance, microfarad capacity, leakage or breakdown. Follow instructions given by manufacturer of test equipment used. (See "Specifications" Section 8.)
7. Inspect distributor cap, rotor and spark plug wires for corrosion or damage.

REASSEMBLY

NOTE: Refer to Figure 1 for clarification of parts.

1. Install vent screen in distributor housing vent hole. Crimp inside flange to secure screen in housing.
2. Place washer on distributor shaft assembly and install shaft through housing. Install washer and collar on shaft. Install pin through collar and shaft. Shaft should have .008" to .010" end play.
3. Install drive gear on distributor shaft (shoulder end first) and install a new pin through gear shoulder and shaft. Peen ends of pin to prevent pin from falling out of gear.
4. Insert oil wick into distributor housing oiler hole and press oiler stem into hole.
5. Install breaker plate screws, identification plate, washers and nuts. Do not tighten nuts. Install breaker plate. Align location marks made during disassembly and tighten screws.
6. Install breaker assembly. Connect breaker assembly lead to distributor primary terminal. Refer to "Setting and Alignment of Points", preceding.
7. Install condenser with bracket and screw. Connect condenser lead to distributor primary terminal.
8. Set rotor on distributor shaft, aligning slot on inside diameter of rotor with flat side of shaft.
9. Install gasket on distributor cap, aligning notch in cap with locating pin on housing, and install cap.

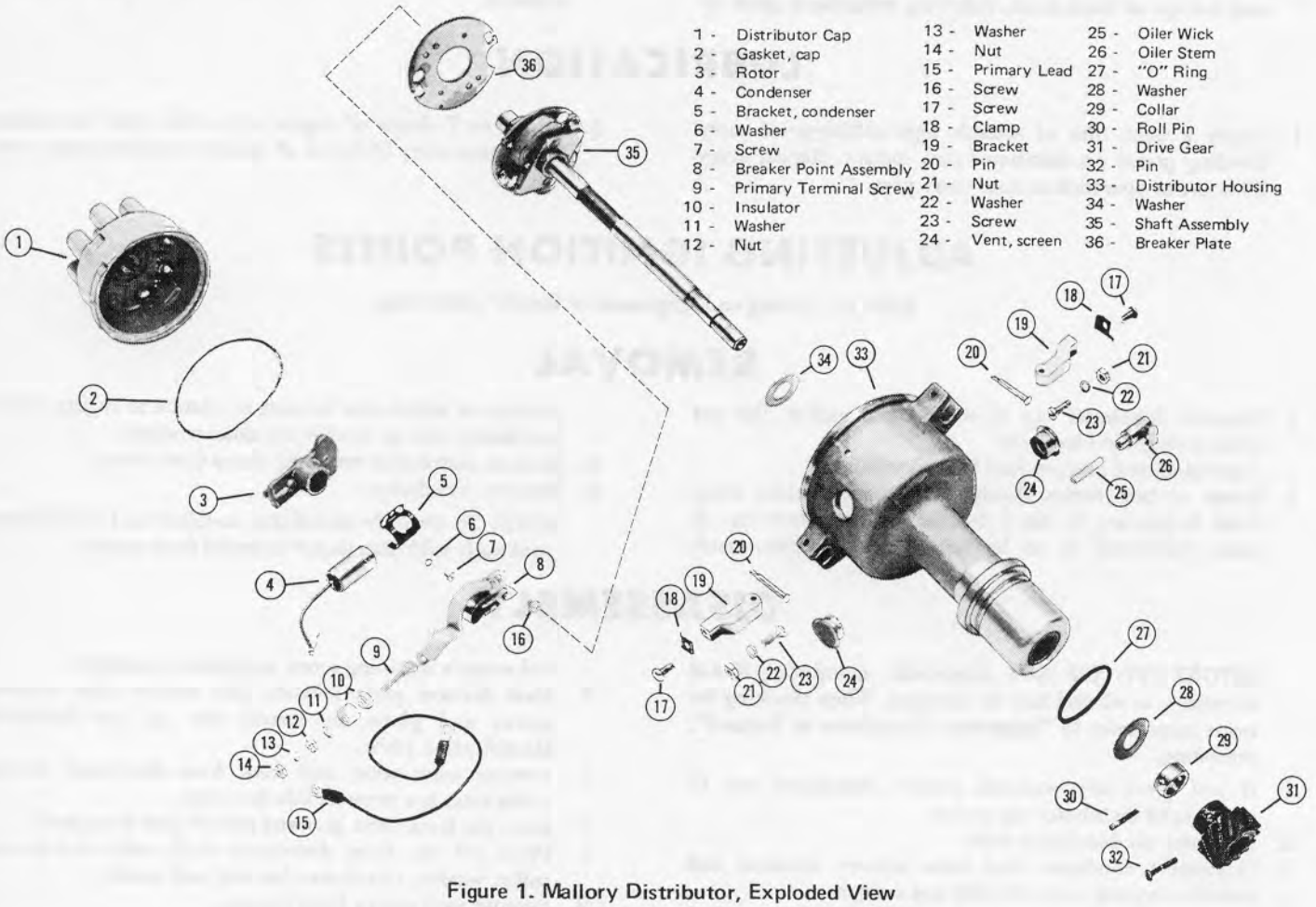

Figure 1. Mallory Distributor, Exploded View

INSTALLATION

1. With rotor installed, place distributor into engine with rotor pointed in same direction as original distributor. (No. 1 tower terminal) Center distributor so that initial timing may be adjusted. (Distributor should rotate approximately (45°.) If original distributor is being installed, align location marks (made during removal) on distributor housing and engine.
2. Install retaining clamp and screw.
3. Connect primary wire between coil primary terminal and distributor primary terminal.
4. Place gasket on distributor cap. Align notch in cap with locating pin on housing and install distributor cap. If new distributor cap is being used, transfer high tension wires from old cap to new cap. Make sure that No. 1 cylinder wire is installed into high tension tower where rotor is pointing. Install remaining wires into cap one-at-a-time in same sequence that wires are removed from original cap.
5. Start engine. Observe oil pressure. No pressure indicates improper seating of distributor shaft with oil pump drive.
6. Use a timing light and set timing as described under "Ignition Timing", preceding.

SECTION 3 - ELECTRICAL SYSTEM

MERCRUISER

PART C - ALTERNATOR SYSTEM

MERCURY MARINE

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TOOLS

All "J-" (Special) Tools Listed in This Section May Be Purchased from:

Kent-Moore, Inc.
28635 Mound Road
Warren, Mich. 48089

ALTERNATOR REGULATOR SYSTEM

DESCRIPTION

MerCruiser diode rectified A.C. alternator is designed and constructed to give long periods of trouble-free service with a minimum amount of maintenance.

The rotor is mounted on a ball bearing at drive end and a roller bearing at slip ring end. Each bearing has a grease supply which eliminates need for periodic lubrication. Brushes and slip rings are totally enclosed in a special brush holder mounted on the end frame. This arrangement provides explosion resistance to meet marine application requirements.

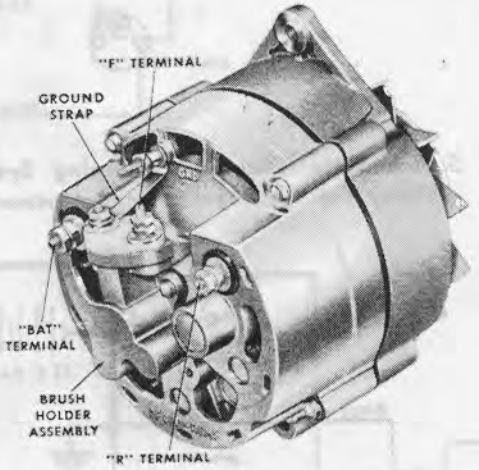

Figure 1. External View

Stator windings are assembled on inside of a laminated core which forms part of alternator frame.

Six rectifier diodes are mounted in slip ring end frame and are connected to stator windings. They replace separately-mounted rectifier, as used in other types of applications. Diodes change alternator A.C. voltage which appears at "BAT" terminal on alternator.

A condenser (mounted in end frame) protects diodes from high voltages.

An external view of a typical alternator is shown in Figure 1, and cross-section views are illustrated in Figures 2 and 3.

There are 2 types of standard alternators: (1) 42 ampere and (2) 32 ampere. The 42 ampere alternator can be identified by No. 1100619-42A (stamped on drive end frame) and the 32 ampere alternator by No. 1100721-32A (stamped on drive end frame). Major components of both alternators are identical, except for rotors which may be interchanged, although not identical.

NOTE: Alternator capacity is 32 amperes with B-38022 rotor installed or 42 ampere with B-33331 rotor installed.

The 2 alternators are used in 3 different regulator circuits (Figures 4, 5 and 6): (1) Relay regulator with indicator light, (2) relay regulator with ammeter and (3) transistor

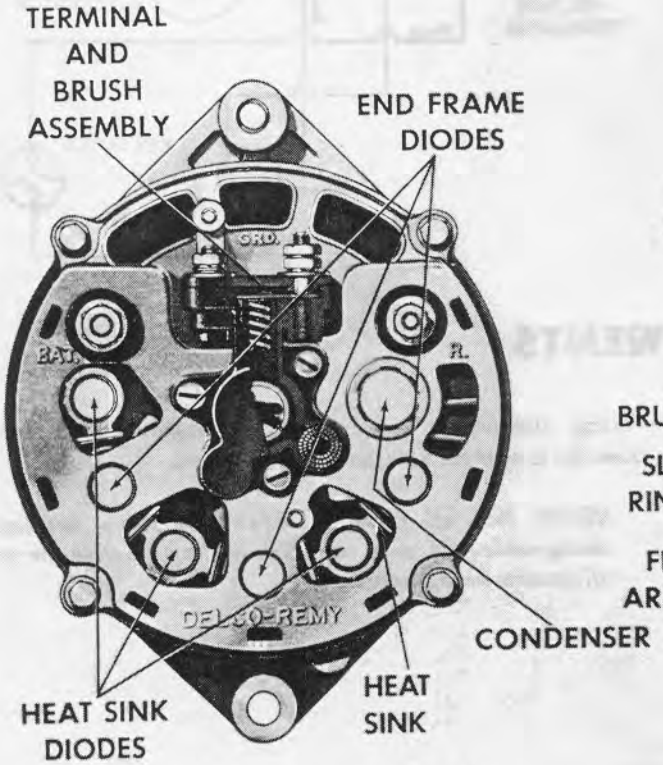

Figure 2. Cross-Section, End View

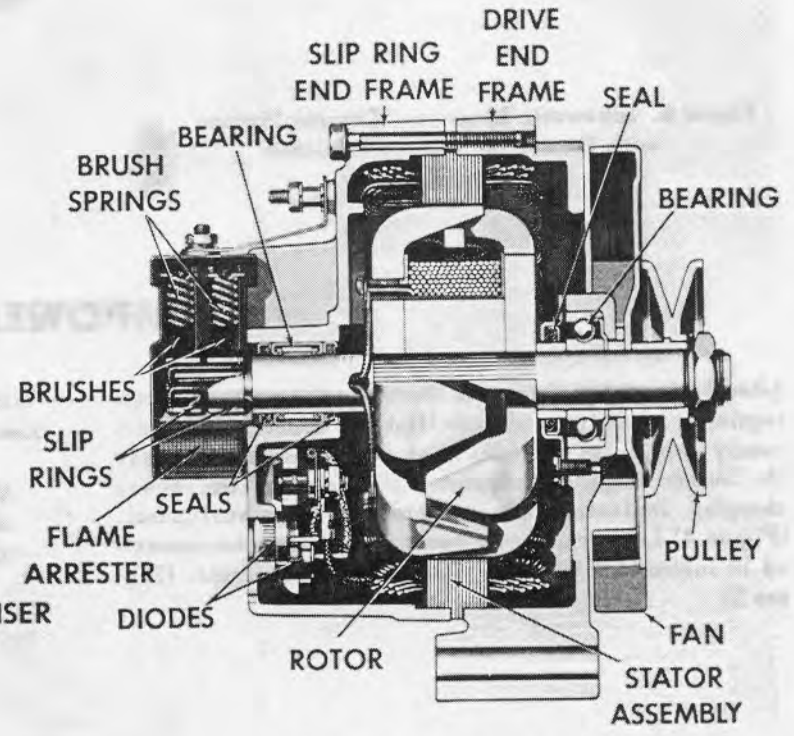

Figure 3. Cross-Section, Side View

regulator with ammeter. Regulators can be identified as follows:

1. Voltage regulators, which are used with indicator light systems, have No. "506" on regulator base.
2. Voltage regulators, which are used with ammeter systems, have No. "507" on regulator base.
3. Transistor voltage regulator (B-37707) can be used only on MerCruiser engines which are equipped with ammeter in instrument panel.

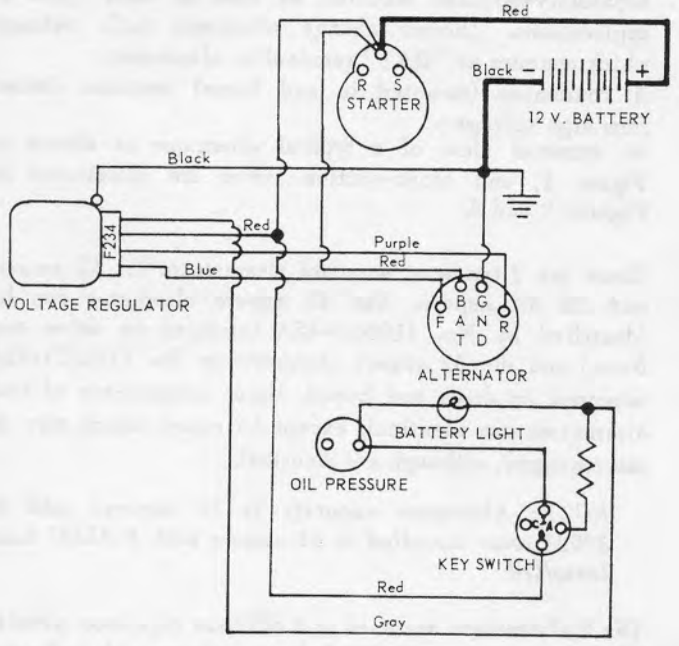

Figure 4. Schmatic Diagram - Charging System, Relay Voltage Regulator with Indicator Light in Instrument Panel

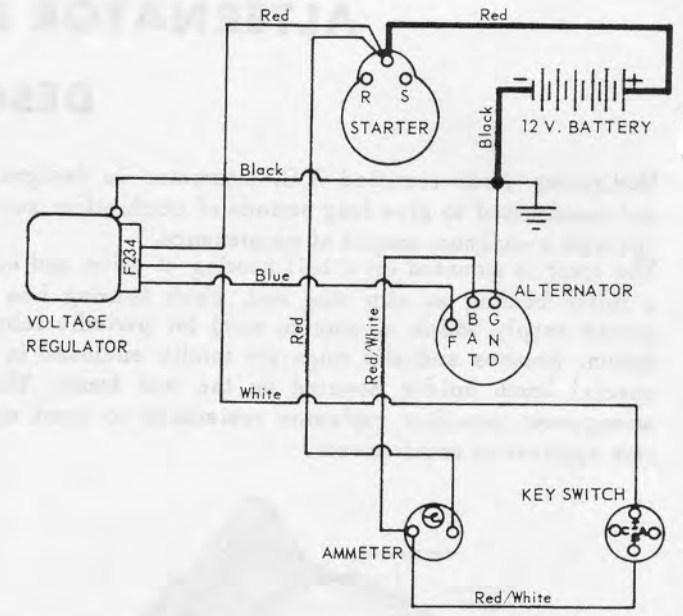

Figure 5. Schematic Diagram - Charging System with Relay Voltage Regulator and Ammeter

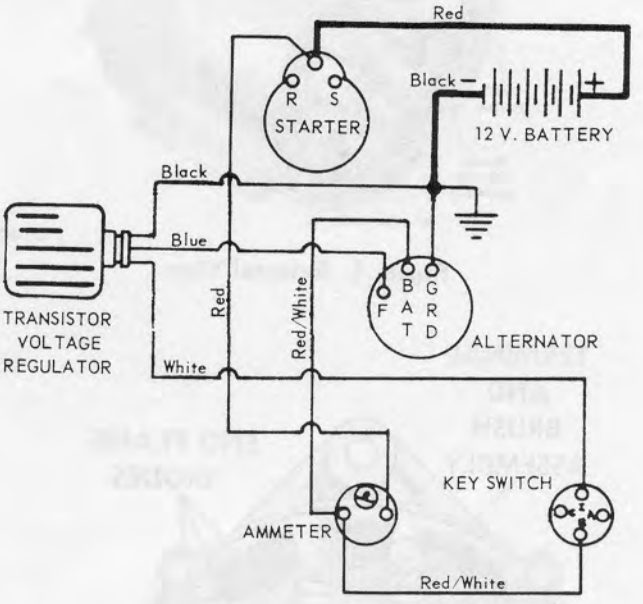

Figure 6. Schematic Diagram - Charging System with Transistor Voltage Regulator and Ammeter

COMPONENTS

Alternator system includes battery, alternator, voltage regulator, charging indicator light or ammeter and necessary wiring to connect these components. On early MerCruiser engine production, alternator system has a charging indicator light mounted in instrument panel. (Figure 4) Later engine production has an ammeter mounted in instrument panel in place of indicator light. (Figure 5)

Wiring circuit for a system with ammeter is different than for a system with an indicator light.

NOTE: Not all parts of these 2 systems are interchangeable. Be sure to follow wiring diagram for type of system being serviced.

PRECAUTIONS

IMPORTANT: Since alternator and regulator are designed for use on one polarity system only, the following precautions must be observed when working on the charging circuit. Failure to observe these precautions will result in serious damage to electrical equipment.

1. When installing battery, always be certain that ground polarity of battery and ground polarity of alternator are the same.
2. When connecting a booster battery, be sure to connect negative (-) battery terminals together and positive (+) battery terminals together.
3. When connecting a charger to battery, connect charger positive (+) lead to battery positive terminal and charger negative (-) lead to battery negative terminal.
4. Never operate alternator on open circuit. Be certain that all connections in circuit are secure.
5. Do not short across or ground any of terminals on alternator or regulator.
6. Do not attempt to polarize alternator.

INSPECTION

Although the MerCruiser alternator is constructed to give long periods of trouble-free service, a regular inspection procedure should be followed to obtain maximum life from the alternator. Frequency of inspection is determined largely by type of operating conditions.

1. At regular intervals, inspect terminals for corrosion and loose connections.
2. Check wiring for frayed or worn insulation.
3. Check mounting bolts for tightness.
4. Check belt for alignment, proper tension and wear. Belt tension should be adjusted as outlined in Step 4, Page 3C-19. When tightening belt tension, apply pressure against stator laminations between end frames and not against either end frame.

TROUBLESHOOTING

Trouble in the charging system will show up as one or more of the following conditions:

1. An undercharged battery as indicated by slow cranking and low specific gravity readings.
2. An overcharged battery as indicated by excessive water usage.

UNDERCHARGED BATTERY

Slow cranking and low specific gravity readings can be caused by one or more of the following conditions:

- Insure that undercharged condition has not been caused by accessories drain for extended periods.
- Check drive belt for proper tension. Adjust as required.
- Check battery for defects and replace if found defective.
- Inspect wiring for shorts or open circuit as follows:

SHORT TEST

1. Disconnect internal wiring harness from electrical components.
2. Using Magneto Analyzer, Scale No. 3, check for continuity between any of the wires in the harness. If continuity exists, harness must be repaired or replaced.

RESISTANCE TEST

1. Turn Magneto Analyzer selector switch to position No. 2 (Distributor Resistance) and clip small red and black leads together.
2. Turn Scale No. 2 meter adjustment knob until meter pointer lines up with set position on left side of "OK" block on Scale No. 2.
3. Unclip small red and black leads.
4. Using wiring diagram as a guide, check each wire for resistance between harness connection and terminal ends.
5. If resistance exists, harness will have to be repaired or replaced.

INSTRUMENT PANEL WIRING HARNESS

Instrument panel wiring harness is checked in same manner as engine wiring harness. Use wiring diagrams as a guide.

1. Check all connections for tightness and corrosion. Clean as required.
2. Connect V-O-A Tester (Volt-Ohm-Ampere, C-91-52751) 0-80 volt scale from "BAT" terminal on alternator to ground. A zero reading indicates an open between "BAT" terminal on alternator and battery.
3. Check field relay in regulator for proper operation. Replace if defective.
4. If previous steps check satisfactorily, perform alternator system output check as follows:

NOTE: Test procedures for 42 ampere and 32 ampere alternator and standard-type and transistor-type voltage regulator are the same, except where indicated.

IMPORTANT: Do not attempt to check charging system in any other manner than described, following, as alternator and/or voltage regulator may be damaged.

a. Disable ignition system by removing coil high tension lead from center of distributor cap and ground this lead to engine block.
b. Connect V-O-A Tester (0-20 volt scale) across battery terminals.
c. Disconnect battery lead from alternator and connect test ammeter (60-0-60) in series with battery terminal on alternator and battery lead.
d. Operate starter 10 to 15 seconds to remove battery surface charge.
e. Reinstall coil high tension lead in distributor cap.
f. Start engine and accelerate to 3000 RPM. While accelerating, observe maximum reading on test ammeter.

42 Ampere Alternator

Reading must be 30 to 45 amps and must diminish to 15 amps or less within a few seconds.

32 Ampere Alternator

Reading must be minimum of 25 amps and must diminish to 15 amps or less within a few seconds.

WARNING: Instantaneous observation of test ammeter must be made during starting and acceleration.

g. When ammeter reading drops to lowest reading, observe V-O-A Tester.
Standard-type voltage reg. - 14-15 volts
Transistor-type volt. reg. - 13.5-14.5 volts
h. If ampere output (specified in Step No. f.) is not reached, proceed as follows:

1. Stop engine and remove blue wire from field terminal on alternator.
2. Start engine and accelerate to 3000 RPM.
3. Connect one end of a jumper lead to "BAT" terminal on alternator and momentarily touch other end of jumper lead to field terminal on alternator. Note reading on ammeter.

CAUTION: Do not touch terminal on end of blue wire with jumper lead, as voltage regulator will be damaged.

4. Ammeter should show following amps when jumper lead is touching field terminal:
42 ampere alternator - 30-to-45 amps
32 ampere alternator - min. of 25 amps
If not, remove alternator and test component parts as described in component checks.

i. Voltage reading, indicated after current drops to lowest value (Step No. 2), should be in following limits:
Standard-type voltage reg. - 14-to-15 volts
Transistor-type volt. reg. - 13.5-to-14.5 volts
If not, it will be necessary to replace regulator. DO NOT ATTEMPT TO ADJUST REGULATOR. After repairing alternator or replacing regulator, complete test procedure once again to assure proper operation.

OVERCHARGED BATTERY

1. Check battery.

IMPORTANT: Remember that an overheated battery will be overcharged even though no charging circuit defects are present.

2. If an obvious overcharge condition exists as indicated by excessive battery water usage and, if battery is not overheated and not defective, remove regulator for repair.

INDICATOR LIGHT OPERATION

1. If light does not illuminate when key is turned to "ON" before engine is started, check for following defects:
   a. Burned out bulb
   b. Socket defective
   c. Wiring defective
   d. Regulator defective
2. If light stays on after engine starts, check for following defects:
   a. Socket defects
   b. Wiring defects
   c. Diode failure
   d. Regulator defective
   e. Drive belt loose

NOISY ALTERNATOR

Noise from alternator may be caused by:
1. Worn or dirty bearings
2. Loose mounting bolts
3. Loose drive pulley
4. Defective diodes
5. Defective stator

ALTERNATOR REMOVAL

CAUTION: Disconnect black ground cable from negative (-) battery terminal to prevent accidental shorting when leads are removed from alternator. Failure to comply with this recommendation may result in damage to diodes and/or alternator system.

1. Disconnect lead wires from terminals on back of alternator.
2. Remove alternator mounting brace bolt and remove drive belt from pulley.
3. Remove bolt and nut, which fasten alternator to support brackets, and remove alternator. Do not lose spacer on bolt.

ALTERNATOR DISASSEMBLY

1. Remove terminal nuts, washers and cover from top of brush holder.
2. Remove studs and brush and spring assemblies.
3. Remove 3 screws, which fasten brush holder to end frame, and remove brush holder.
4. Remove 4 thru-bolts and separate drive end frame and rotor assembly from stator assembly by prying apart with a screwdriver at slot located in stator frame. A scribe mark will help locate parts in same position during reassembly. Fit between stator and frame is not tight and they can be separated easily.

   NOTE: Separate between stator frame and drive end frame.

5. Place a piece of tape over slip ring end frame on both sides of bearing to prevent entry of dirt. Place piece of tape over bearing surface on shaft to prevent damage to shaft.

   NOTE: Do not use black friction tape. Use only pressure sensitive tape that will not contaminate shaft surface.

6. Remove drive end from rotor by placing rotor in vise and tighten vise only enough to permit removal of shaft nut.

> **CAUTION: Over-tightening vise will cause rotor distortion.**

7. Remove shaft nut, washer, pulley, fan and collar and separate drive end frame from rotor shaft.

COMPONENT CHECKS

ROTOR

ROTOR TEST FOR GROUND

1. With Magneto Analyzer selector switch set on Scale No. 3 (Continuity), or using V-O-A Tester on scale R x 1, place one lead on either slip ring and other lead on rotor shaft or poles. (Figure 7)
2. If meter hand on Analyzer or V-O-A moves to right, rotor is grounded.

ROTOR TEST FOR OPEN CIRCUIT

1. With Magneto Analyzer selector switch set on Scale No. 3 (Continuity), or using V-O-A tester on scale R x 1, place one lead on each slip ring. (Figure 7)
2. If meter hand on Analyzer or V-O-A does not move to right, rotor is open.

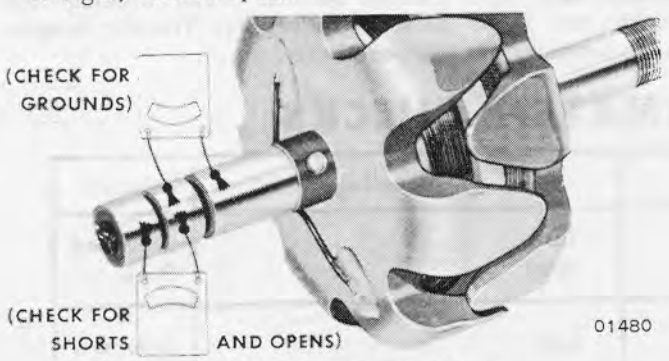

Figure 7. Testing Rotor

ROTOR TEST FOR SHORT CIRCUIT

1. With Magneto Analyzer selector switch set on Scale No. 2 (Resistance), or V-O-A Tester set on R x 1 scale, place one lead on each slip ring. (Figure 7)
2. If reading on meter is below 6 ohms for 42 ampere rotor or 4.5 ohms for 32 ampere rotor, rotor windings are shorted.

   NOTE: To adjust Magneto Analyzer meter for this test, do not clip small red and black leads together. Turn No. 2 meter scale adjusting knob until meter needle lines up with red line on right side of Scale No. 2 on meter.

DIODE TESTS

Each diode may be checked electrically for a shorted or open condition.

1. Set Analyzer selector switch on Scale No. 3 (Continuity), or V-O-A Tester set on R x 1 scale.
2. With stator leads disconnected, check a diode in heat sink by connecting one test lead to heat sink and other test lead to diode lead. (Figure 8) Note reading on meter Scale No. 3 (Figure 9) or ohms scale on V-O-A Tester.

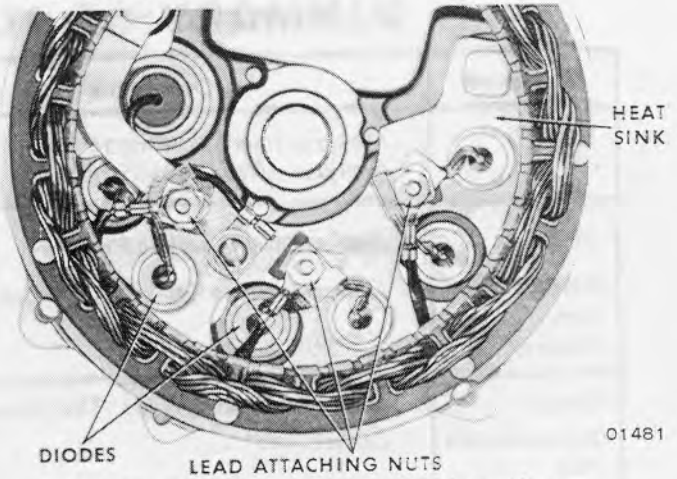

Figure 8. Stator Lead Attaching Nuts

3. Reverse test leads and note reading on meter.
4. If both readings are zero or very high, diode is defective. A good diode will give one low reading and one high reading.

Figure 9. Testing Diodes

5. Check other 2 diodes in heat sink in same manner.
6. To check diodes mounted in end frame, follow Steps 1-thru-6, preceding, with exception that test leads should be connected to end frame and diode lead. (Figure 9)

STATOR

STATOR TEST FOR GROUND

1. Remove all 3 stator lead attaching nuts (Figure 8) and separate stator assembly from end frame. Fit between stator frame and end frame is not tight and can be separated easily.
2. With Magneto Analyzer selector switch on Scale No. 3 (continuity), or using V-O-A Tester on Scale R x 1, connect one test lead to any one of the 3 stator leads.
3. Place other tester lead on stator frame. (Figure 10)
4. If meter hand on Analyzer or V-O-A Tester moves to right, windings are grounded.

STATOR TEST FOR OPEN CIRCUIT

1. Stator must be removed from end frame as described in "Stator Test for Ground", above, Step No. 1.
2. With Magneto Analyzer selector switch on Scale No. 3 (Continuity), or using V-O-A Tester on scale R x 1, connect tester leads successively between each pair of stator leads. (Figure 10)

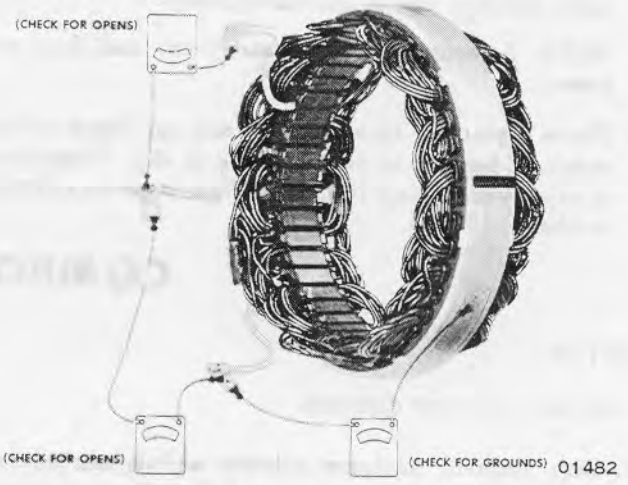

Figure 10. Testing Stator

3. If meter hand on Analyzer or V-O-A Tester does not move to right, windings are open.

STATOR TEST FOR SHORT CIRCUIT

Because of low resistance of windings, a short circuit in stator windings is difficult to locate without laboratory test equipment. However, if all other following electrical checks are normal, and alternator fails to supply rated output, shorted stator windings are indicated. Also, a ground may have existed between stator windings and either end frame before disassembly. Visually inspect very carefully for this possibility.

SUMMARY OF ALTERNATOR CHECKS

Component	Connection	Reading	Result
Rotor	Analyzer from Slip Ring to Shaft Analyzer across Slip Rings	Low High	Grounded Open
Stator (Disconnected from Diodes)	Analyzer from Lead to Frame Analyzer across Each Pair of Leads	Low High	Grounded Open
Diode (Disconnected from Stator)	Analyzer across Diode, Then Reverse Connections	Both Readings Very Low Both Readings Very High	Shorted Open

VOLTAGE REGULATOR (RELAY AND TRANSISTOR)

Because voltage regulator can be obtained at a relatively low cost, replace if it does not conform to test specifications of alternator charging system check.

NOTE: Before replacing regulator, be sure that base of regulator is properly grounded and connector strip is not loose when making check.

After replacing regulator, perform alternator charging system check to assure proper system operation.

BRUSH and BRUSH HOLDER REPLACEMENT

1. If brushes are worn over 50 percent, replace. When replacing brushes, slip rings also should be cleaned, as explained under "Slip Ring Servicing".
2. Place brush assemblies in brush holders and install terminal studs.
3. Position cover on brush holder and place washers and nuts (which hold cover in place) on terminal studs.

NOTE: Pin (inserted thru brush holder) retains brushes in holder. Do not withdraw pin until after holder has been assembled onto end frame.

4. Install brush holder assembly, using gasket and 3 pan head screws. ("A" in Figure 11)

IMPORTANT: Always use correct brush holder screws and washers. If screws are too long, they will bottom against heat sink and ground out alternator.

5. Pull brush retaining pin out of brush holder.
6. Fasten ground strap to left brush holder stud with flat washer, wave washer and nut.
7. Fasten ground strap to alternator end frame with flat washer, lockwasher and stud.
8. Coat all metal surfaces of both terminals on brush holder ground strap and ground stud with Liquid Neoprene (C-92-25711).
9. Seal brush retaining pin hole in brush holder with a very small amount of Liquid Neoprene. Do not use too much, as any excess (which runs inside brush holder) will cause brushes to stick.

NOTE: Parts for early brush holder assemblies are no longer available. If replacement parts are required, install new alternator brush holder assembly (B-34754) on all engines with Serial No. 1963419 and below.

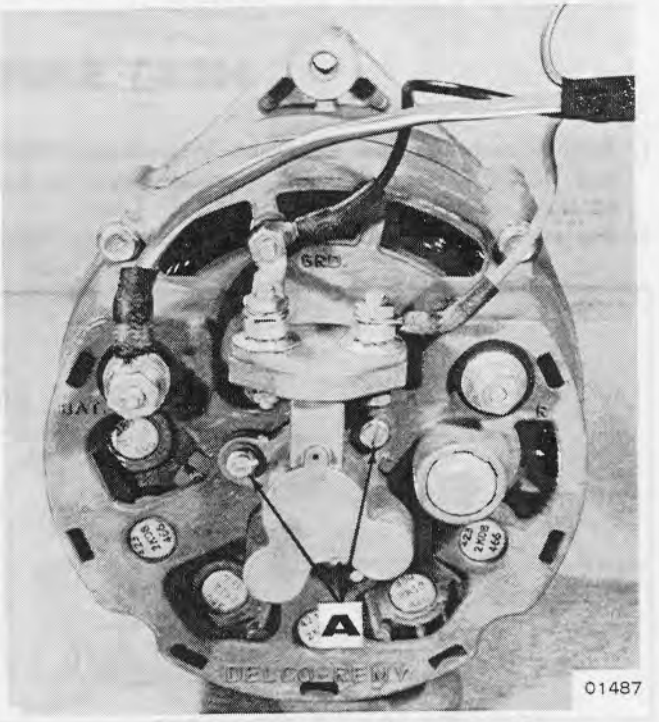

Figure 11. Brush Holder Assembly

SLIP RING SERVICING

1. If slip rings are dirty, clean and finish with 400 grain or finer polishing cloth. Spin rotor and hold polishing cloth against slip rings until clean.
2. Slip rings, which are rough or out-of-round, should be trued in a lathe to .002" maximum indicator reading. Remove only enough material to make rings smooth and round.
3. Finish with 400 grain or finer polishing cloth and blow away any dust.

CAUTION: Rotate rotor so that slip rings will be cleaned evenly. Cleaning slip rings by hand without spinning rotor may result in flat spots on slip rings, thus causing brush noise. Support journal on a steady rest with rollers. Do not use "V" blocks, as they may damage journal.

DIODE REPLACEMENT

END FRAME (NEGATIVE DIODES)

1. Support end frame with Support Tool J-9717-2 and press out diode with Removal Tool J-9717-1.
2. Support outside of end frame around diode hole on a

CAUTION: Do not strike diode, as shock may damage other diodes.

flat, smooth surface and press diode into position with Tool J-9600-2. Make sure that diode is square with end frame and started straight.

CAUTION: Avoid bending or moving diode stem, as excessive movement can cause internal damage and result in diode failure.

HEAT SINK (POSITIVE DIODES)

NOTE: It is not necessary to remove heat sink to remove or install positive (+) diodes.

1. Support heat sink with Support Tool J-9717-2 and press out diode with Removal Tool J-9717-1.

CAUTION: Do not strike diode, as shock may damage other diodes.

2. Support heat sink with Support Tool J-9717-2 and press diode into position with Tool J-9600-2. Be certain that diode is square with heat sink and started straight.

CAUTION: Avoid bending or moving diode stem. Excessive movement can cause internal damage and result in diode failure.

HEAT SINK REPLACEMENT

1. Remove heat sink from end frame by removing "BAT" and "GRND" terminal bolts. Note sequence of parts for reassembly.
2. Replace diodes, if necessary, as outlined in "Diode Replacement", preceding.
3. Assemble heat sink to end frame, carefully following proper sequence of parts on "BAT" and "GRND" terminal bolts. (Figure 12)

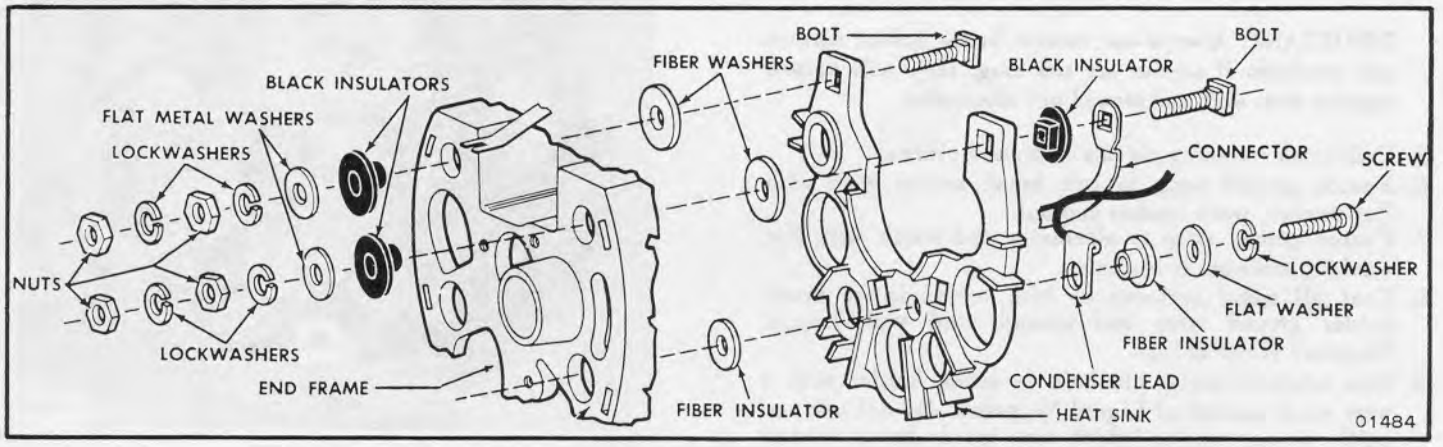

Figure 12. Part Sequence

SLIP RING END FRAME BEARING

NOTE: If grease supply in end frame bearing is exhausted, bearing should be replaced. Do not relubricate bearing.

1. Support end frame on hollow cylinder.
2. Press bearing toward inside of frame with mandrel that will just fit inside end frame housing. Carefully note assembly of seals so that they can be reassembled in same manner.
3. Support inside of frame with hollow cylinder to prevent breakage of end frame.

CAUTION: Assemble seals flush with bearing, but avoid excessive pressure, since this may distort and damage seals. It is recommended that new seals be used whenever bearing is replaced.

4. Place bearing on frame and press into position with mandrel from outside toward inside of frame until bearing is located as shown in Figure 13.
5. Saturate felt seal with SAE 20 oil, then reassemble seals into end frame.

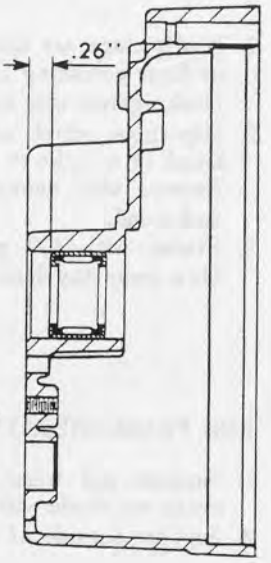

Figure 13. Bearing Pressed into Position

DRIVE END FRAME BEARING REPLACEMENT

1. Remove 3 bearing retainer plate screws.
2. Support frame on hollow cylinder and press bearing toward inside of frame until it is removed. Remove grease slinger.
3. If bearing is in satisfactory condition, it may be reused, and it should be filled one-quarter full with Delco-Remy Lubricant No. 1960373 before reassembly.
4. Place new grease slinger in frame and press bearing in frame with tube or collar which will just fit over outer race.
5. If felt seal in retainer plate is hardened or worn, install new retainer plate assembly.

CAUTION: Do not overfill, as this may cause bearing to overheat.

ALTERNATOR REASSEMBLY

1. Slide wide collar on pulley end of rotor shaft.
2. Place rotor shaft thru drive end frame bearing and seals.
3. Place narrow collar, fan, pulley, wave washer and nut on rotor shaft.
4. Place rotor in vise and tighten only enough to permit tightening shaft nut to 50-60 ft. lbs. (6.9-8.3 mkg).
5. Place stator assembly in end frame and connect leads to attaching studs with nuts.
6. Place end frame assemblies together, lining up scribe marks made on frames before disassembly.
7. Install 4 thru bolts and tighten evenly.
8. Wipe slip rings thoroughly with a soft dry cloth to remove lubricant accumulated when rings were inserted thru bearings during assembly.

CAUTION: Over-tightening vise will cause distortion of rotor.

REPLACEMENT ALTERNATOR INSTALLATION

NOTE: When installing replacement alternator (B-32701), make sure that unit is mounted so that slip ring end frame and brush holder assembly are located in same position as on replaced unit. This may require rotating slip ring end frame on new unit. To do this, remove thru bolts and rotate slip ring end frame either 90° or 180°, then replace thru bolts.

CAUTION: Do not separate end frames, as brushes will drop off slip rings. If this happens, remove brush holder, clean slip ring and reinstall brush holder as explained under "Slip Ring Servicing" and "Brush Replacement", following.

1. Install bolt, spacer and nut which fasten alternator to support brackets.
2. Swing alternator toward engine and place drive belt on pulley.
3. Install mounting brace bolt and washer, but do not tighten belt.
4. Adjust belt tension by depressing belt midway between water pump pulley and alternator pulley with strand tension gauge.
5. Adjust alternator on its mounting bracket until belt tension is sufficient to read 45 lbs., and tighten brace bolt securely.

   NOTE: In emergency, tension may be adjusted by depressing belt midway between water pump pulley and alternator pulley with thumb. Belt should not depress more than ½" (12.7mm).

6. Connect ends of engine wiring harness to alternator. Refer to Figure 14 if system has indicator light, or to Figure 15 if system has ammeter.
7. Run engine and carry out "Alternator Charging System Check".

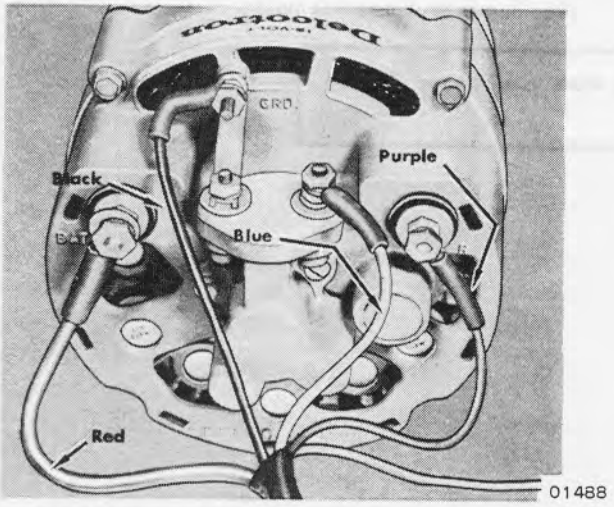

Figure 14. Alternator Wiring Connections - Indicator Light in System

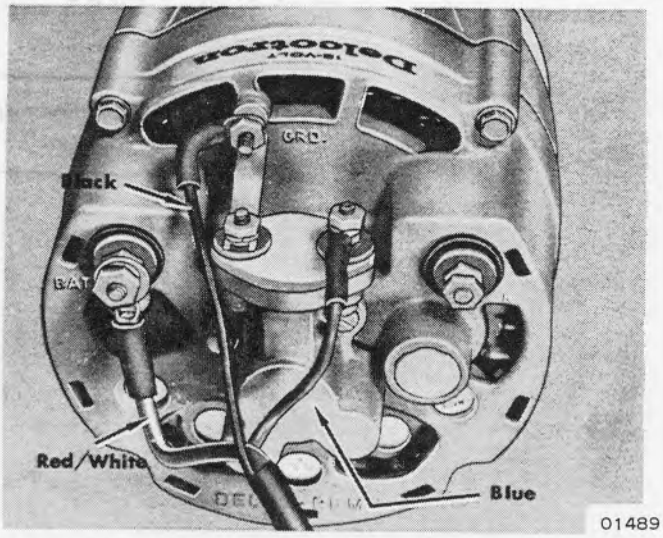

Figure 15. Alternator Wiring Connections - Ammeter in System

VOLTAGE REGULATOR REPLACEMENT

RELAY TYPE

1. Lift latch, which secures wiring harness connector to regulator, and pull connector away from regulator.
2. Remove screws which fasten regulator to mounting bracket.

NOTE: Voltage regulator, which is used with indicator light systems, has number "506" on regulator base. Regulator, which is used with ammeter systems, has number "507" on regulator base.

(Refer to Figure 16 or 17 for wire connections.)

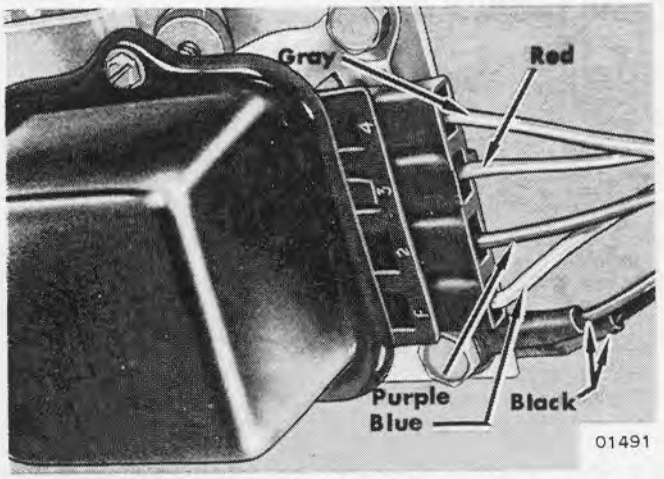

Figure 16. Voltage Regulator Wire Connections - Indicator in System

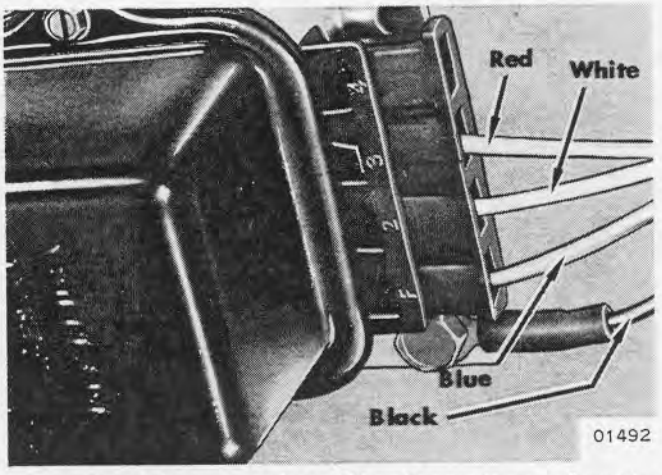

Figure 17. Voltage Regulator Wire Connections - Ammeter in System

NOTE: Voltage regulator must be mounted on vibration dampening mounting bracket. Bracket was not supplied with early MerCruiser engines. When installing voltage regulators for these engines, use B-33614A1 voltage regulator mount assembly.

3. Plug connector on wiring harness into voltage regulator while matching terminals on both parts.
4. Position regulator and vibration dampening mounting bracket on transom so that harness leads to regulator are not drawn tight.
5. Mark location of regulator mounting bracket on transom.
6. Remove 3 screws, which fasten regulator to mounting bracket, and remove regulator.
7. Remove 2 wood screws, which pass thru rubber grommets, and re-insert with points in opposite direction. Be sure that washers and bushings are in same positions as before turning screws around.
8. Fasten mounting bracket to transom with 2 wood screws. (Figure 18) Be sure 2 mounting screws are in vertical position.

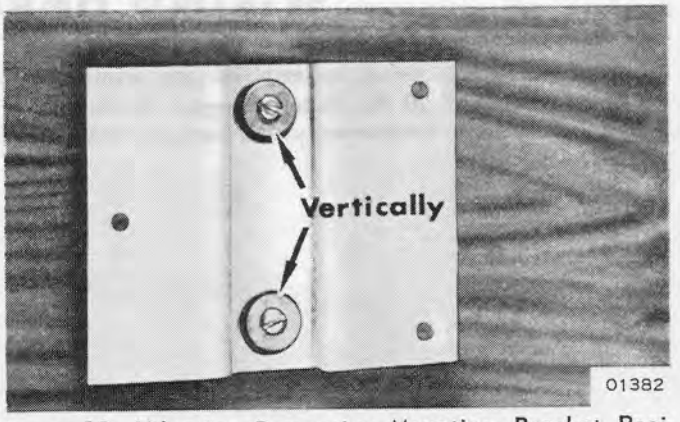

Figure 18. Vibration Dampening Mounting Bracket Position on Transom

9. Place terminal of black harness lead on one regulator attaching screw and fasten regulator to mounting bracket with 3 screws. (Figure 19)

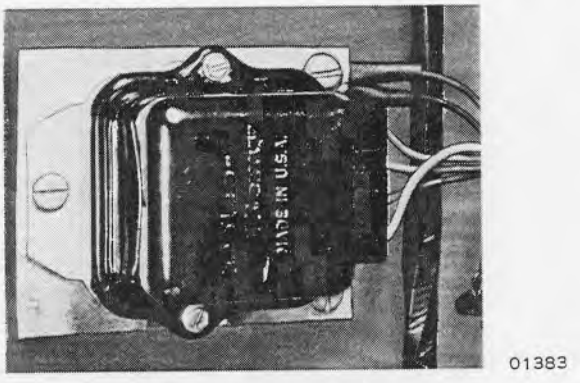

Figure 19. Regulator Position on Mounting Bracket

10. Secure engine harness to transom with clip so that wire between clip and regulator is not drawn tight. Regulator and mounting bracket must move freely.

TRANSISTOR TYPE

Voltage regulator B-37707 can be used only on MerCruiser Marine Engines equipped with ammeter in instrument panel.

To adapt engine harness for use with transistor voltage regulator, refer to instructions which accompany the regulator kit.

VOLTAGE REGULATOR EXTENSION HARNESS

Harness extension assembly (B-37460A1) is a replacement, if original voltage regulator connector or connector wires are damaged. Harness extension assembly will fit either voltage regulator B-32702 or B-34141 and includes all terminals, screws and nuts necessary for attachment to engine wiring harness. (Figure 20) Refer to instructions which accompany harness extension assembly (B-37460A1).

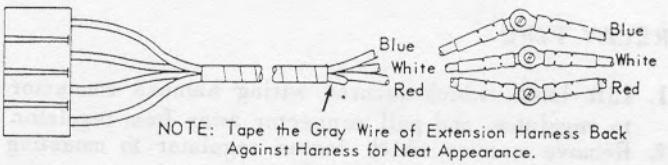

Figure 20. Harness Extension Assembly with Ammeter

WIRING HARNESS EXTENSIONS

Wiring harness extension assemblies are available in 10 ft. (3.05m) and 20 ft. (6.1m) lengths. Extension is connected between instrument panel harness and engine wiring harness on longer boats. Harness extension assembly includes a terminal block and necessary fasteners.

INTEGRAL CHARGING SYSTEM

DESCRIPTION

Integral charging system (Figures 1 and 2) features an explosion-resistant screen at each end frame and a solid state regulator that is mounted inside the slip ring end frame. All regulator components are enclosed, and this unit (along with the brush holder assembly) is attached to the slip ring end frame. Regulator voltage setting never needs adjusting, and no provision for adjustment is provided.

Rotor bearings contain a supply of lubricant sufficiently adequate to eliminate need for periodic lubrication. Two brushes carry current thru 2 slip rings to field coil mounted on rotor and, under normal conditions, will provide long periods of attention-free service.

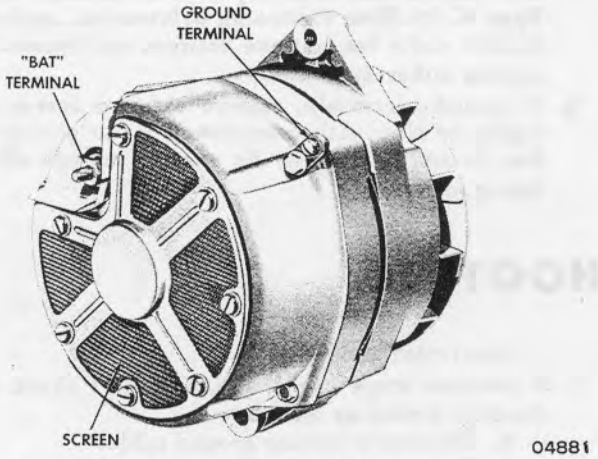

Figure 1. External View

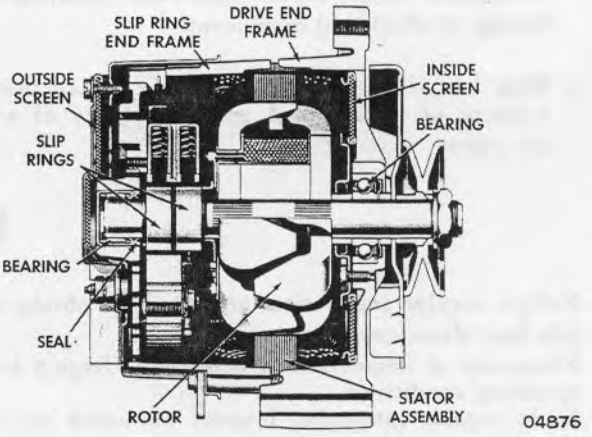

Figure 2. Cross-Section, Side View

Stator windings are assembled on inside of a laminated core that forms part of the frame. A rectifier bridge (connected to stator windings) contains 6 diodes and electrically changes stator A.C. voltages to D.C. voltage which appears at output terminal. Field current is supplied thru a diode trio which also is connected to stator windings. A condenser (mounted in end frame) protects rectifier bridge and diode trio from high voltages and suppresses radio noise.

COMPONENTS

Alternator system includes battery, alternator, ammeter and necessary wiring to connect these components. Figure 2 shows internal components of alternator.

Wiring circuit for system is shown in Figures 3 and 4.

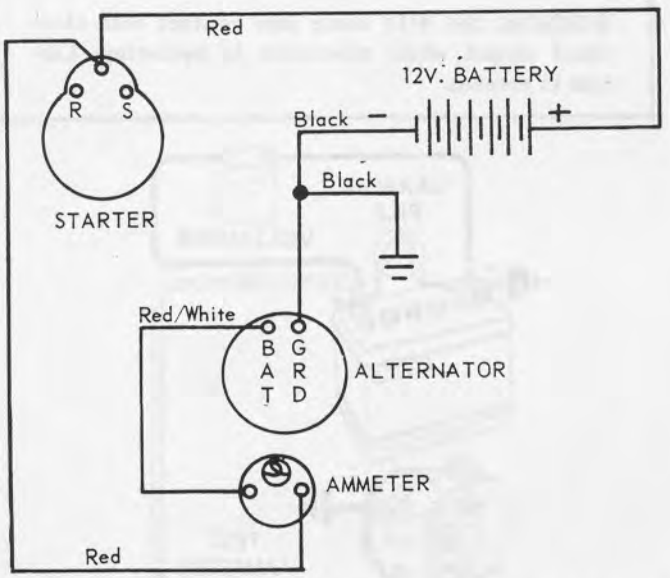

Figure 3. Schematic Diagram - Internal Charging System Harness Length 20 Ft. or Less

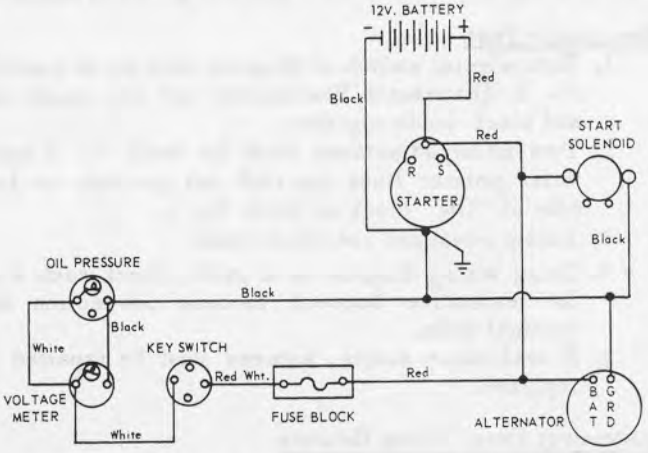

Figure 4. Schematic Diagram - Integral Charging System Harness Length More Than 20 Ft.

PRECAUTIONS

IMPORTANT: Since alternator is designed for only one polarity system, following precautions must be observed when working on charging circuit. Failure to observe these precautions will result in serious damage to electrical equipment.

1. When installing battery, always be certain that ground polarity of battery and ground polarity of alternator are same.
2. When connecting a booster battery, make certain to connect negative (-) battery terminals together and positive (+) battery terminals together.
3. When connecting a charger to battery, connect charger positive lead to battery positive terminal and charger negative lead to battery negative terminal.
4. Do not short across or ground any terminals on alternator or regulator.
5. Do not attempt to polarize alternator, unless instructed.

INSPECTION

Follow regular inspection procedure to obtain maximum life from alternator.

Frequency of inspection is determined largely by type of operating conditions.

1. At regular intervals, inspect terminals for corrosion and loose connections.
2. Check wiring for frayed or worn insulation.
3. Check mounting bolts for tightness.
4. Check belt for alignment, proper tension and wear. Belt tension should be adjusted as outlined in Step 4, Page 3C-19. When tightening belt tension, apply pressure against stator laminations between end frames and not against either end frame.
5. At periodic intervals, remove external screen and tap lightly or blow with compressed air to prevent screen from becoming clogged. Be sure to replace all screws during reassembly.

TROUBLESHOOTING

Trouble in charging system will show up as one of following conditions:

1. Undercharged battery, as indicated by slow cranking and low specific gravity readings.
2. Overcharged battery, as indicated by excessive water usage.

UNDERCHARGED BATTERY

Short Test

1. Disconnect internal wiring harness from electrical components.
2. Using Magneto Analyzer, Scale No. 3, check for continuity between any of wires in harness. If continuity exists, harness must be repaired or replaced.

Resistance Test

1. Turn selector switch of Magneto Analyzer to position No. 2 (Distributor Resistance) and clip small red and black leads together.
2. Turn meter adjustment knob for Scale No. 2 until meter pointer lines up with set position on left side of "OK" block on Scale No. 2.
3. Unclip small red and black leads.
4. Using wiring diagram as a guide, check each wire for resistance between harness connection and terminal ends.
5. If resistance exists, harness must be repaired or replaced.

Instrument Panel Wiring Harness

Instrument panel wiring harness is checked same as engine wiring harness. Use wiring diagrams as a guide.

1. Connect a voltmeter from "BAT" terminal to ground. Zero reading indicates an open between voltmeter connection and battery.
2. If previous steps check satisfactorily, check integral charging system as follows:
   a. Disconnect battery ground cable.
   b. Connect ammeter in circuit at "BAT" terminal of integral charging system.
   c. Connect a carbon pile across battery. (Figure 5)
   d. Reconnect battery ground cable and turn on accessories.

WARNING: DO NOT come into contact with electrical circuit while alternator is operating. Current is present.

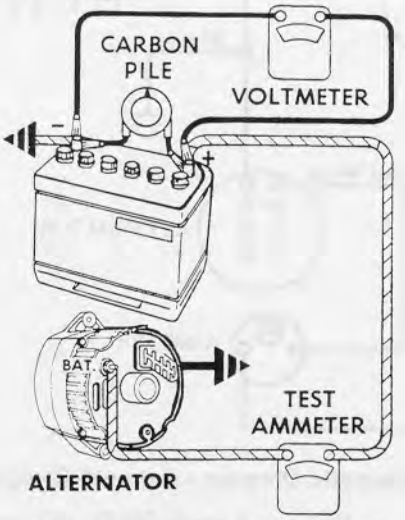

Figure 5. Alternator Output Test

e. Operate engine at moderate speed as required (usually 4000 generator RPM or more) and adjust carbon pile to obtain maximum current output.

IMPORTANT: Initial voltage buildup is by residual magnetism in rotor. Increase speed, as required, to obtain maximum current output.

f. If ampere output is within 10 percent of rated output (as stamped on generator frame) integral charging system is not defective. Recheck previous steps.
g. If ampere output is not within 10 percent of rated output (as stamped on integral charging system frame) record maximum amperes that can be obtained, then remove explosion-resistant screen from slip ring end.
h. Ground field winding by inserting screwdriver into test hole in end frame.

CAUTION: Tab is within ¾" (19mm) of casting surface. Do not force screwdriver deeper than 1" (25mm) into end frame.

Operate generator at moderate speed and adjust carbon pile, as required, to obtain maximum output. If output is within 10 percent of rated output, replace regulator.

If output is not within 10 percent of rated output, check field winding, diode trio, rectifier bridge and stator.

3. If obvious overcharge condition exists (as evidenced by excessive battery water usage) and, if battery is not overheated and not defective, remove integral charging system for repair.

OVERCHARGED BATTERY

1. Check battery.

IMPORTANT: Remember that an overheated battery will be overcharged although no charging circuit defects are present.

NOISY ALTERNATOR

Noise from alternator may be caused by:

1. Worn or dirty bearings
2. Loose mounting bolts
3. Loose drive pulley
4. Defective diode trio
5. Defective stator

ALTERNATOR REMOVAL

CAUTION: Disconnect black ground cable from negative (-) battery terminal to prevent accidental shorting when leads are removed from alternator. Failure to comply with this recommendation may result in damage to diodes and/or alternator system.

1. Disconnect lead wires from terminals on back of alternator.
2. Remove alternator mounting brace bolt and remove drive belt from pulley.
3. Remove bolt and nut, which fasten alternator to support brackets, and remove alternator. Do not lose spacer on bolt.

DISASSEMBLING INTEGRAL CHARGING SYSTEM

1. Remove 4 thru bolts from drive end, then remove cover.
2. Clamp 5/16" Allen wrench in vise and insert Allen wrench into shaft end as shown in Figure 6. Using 15/16" box wrench, loosen end nut and remove nut, washer, pulley, fan, collar drive end frame and collar from rotor shaft.
3. Pull rotor assembly from slip ring end frame, being careful not to lose brush springs.
4. After disassembly, place a piece of tape over slip ring end frame bearing (to prevent entry of dirt and other foreign material) and also over shaft on slip ring end. If re-using brushes, clean with a soft, dry cloth.

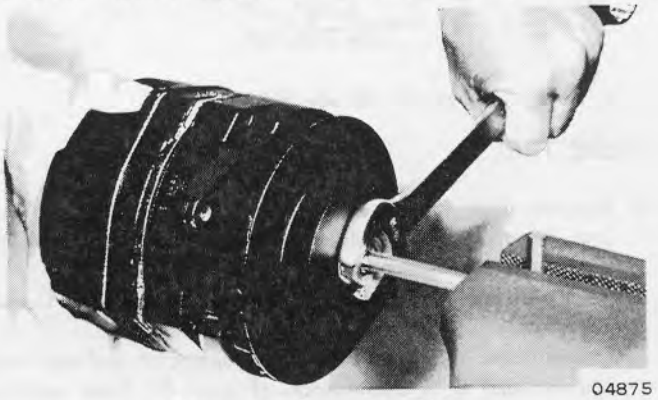

Figure 6. Removing Nut

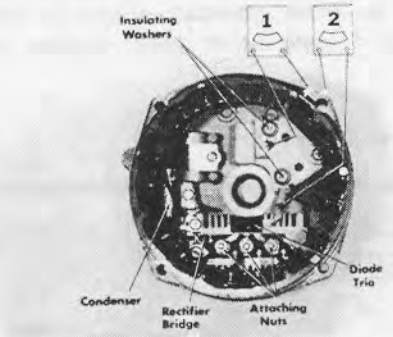

Figure 7. Brush Lead Clip Checks

CAUTION: Use pressure-sensitive tape, not friction tape, which leaves a gummy deposit on shaft.

5. Before reassembly, magnetize rotor field winding by connecting positive (+) post of a 12-volt battery to edge of outer slip ring and negative (-) post to inside slip ring nearest to field winding.
6. Pull stator assembly from slip ring frame end.
7. Remove 3 attaching nuts (Figure 7) and phillips head screw from slip ring frame end and remove diode trio.
8. Remove remaining 2 phillips head screws from brush holder assembly and remove brush holder and voltage regulator.

IMPORTANT: Two insulators are located under 2 brush clip screws. These screws have special insulating sleeves over the screw body. Third mounting screw may or may not have an insulating sleeve. If not, this screw must be interchanged with either of the other 2 screws, as a ground may result, causing no output or uncontrolled generator output. Regulators may vary in appearance but are completely interchangeable in these generators.

9. Remove 2 screws, and disconnect capacitor leads and remove capacitors.
10. To remove rectifier bridge, remove attaching screw and "BAT" terminal screw.

NOTE: Rectifier bridges may vary in appearance but are completely interchangeable in these generators.

COMPONENT CHECKS

REGULATOR

1. Set Analyzer selector switch on Scale No. 3 (Continuity) or use V-O-A Tester (C-91-52751) on Rx1 scale.
2. Connect one test lead from brush lead clip and other lead to end frame, as shown in Step 1. (Figure 7) Note reading on meter Scale No. 3 or V-O-A.
3. Reverse test leads and note reading on meter.
4. If both readings are zero, either brush lead clip is grounded or regulator is defective.
5. A grounded brush lead clip may result from omission of insulating washer (Figure 7), ommission of insulating sleeve over screw or damaged insulating sleeve. Remove screw to inspect sleeve. If satisfactory, replace regulator as described under "Disassembly".
6. Repeat Steps 1-thru-5, above, except to connect Analyzer or V-O-A as shown in Step 2. (Figure 7)

NOTE: Since regulator is completely enclosed, no practical method to check this unit with a test instrument exists. If none of previous checks show any defects, and maximum generator output (as previously checked) was 5 amperes or less, replace regulator.

ROTOR

ROTOR TEST for GROUND

1. With Magneto Analyzer selector switch set on Scale No. 3 (Continuity), or using V-O-A Tester on Rx1 scale, place one lead on either slip ring and other lead on rotor shaft or poles. (Figure 8)
2. If meter hand on Analyzer or V-O-A Tester moves to right, rotor is grounded.

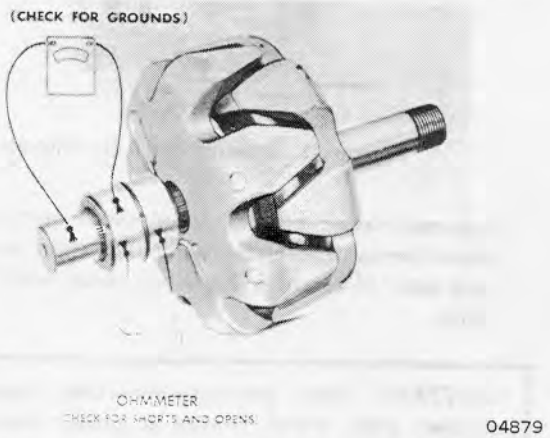

Figure 8. Checking Rotor for Shorts or Opens

ROTOR TEST for SHORT CIRCUIT

1. With Magneto Analyzer selector switch set on Scale No. 2 (Resistance) or the V-O-A Tester on Rx1 scale, place one lead on each slip ring. (Figure 8)
2. If reading on meter is below 2.6 ohms, rotor windings are shorted.

NOTE: To adjust Magneto Analyzer for this test, do not clip small red and black leads together. Turn No. 2 meter scale adjusting knob until meter needle lines up with red line on right side of Scale No. 2.

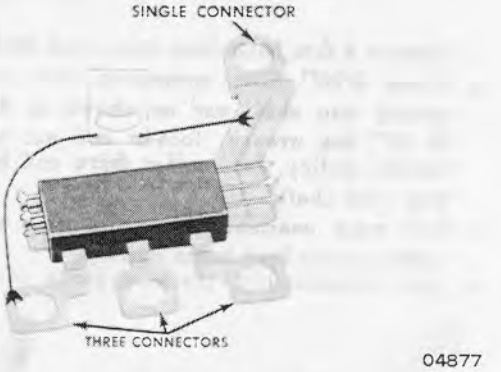

Figure 9. Diode Trio Checks

DIODE TRIO

1. Remove diode trio from end frame assembly by removing 3 nuts and attaching screw. Check each diode electrically for shorted or open condition.
2. Set Analyzer selector switch on Scale No. 3 (Continuity) or V-O-A Tester on Rx1 scale.
3. Connect one test lead to single connector and one test lead to one of 3 connectors. (Figure 9) Note reading on scale.

4. Reverse test leads and note reading on meter.
5. If both readings are zero, or both readings are very high, diode is defective. A good diode will give one low reading and one high reading.
6. Repeat Steps 3-thru-5 between single connector and each of the other 2 connectors.
7. Replace diode trio, if defective.

RECTIFIER BRIDGE

NOTE: Do not perform this check for an overcharged battery condition.

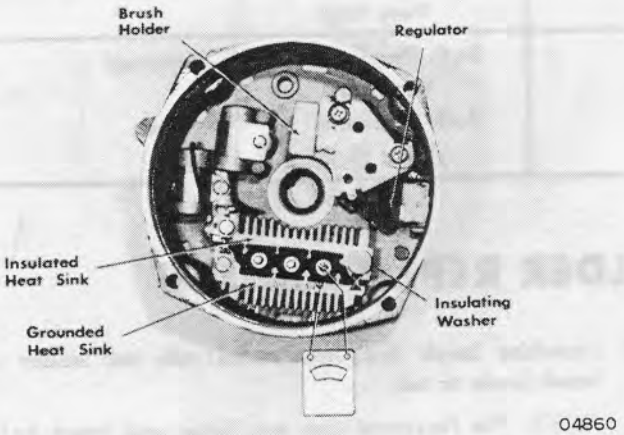

Figure 10. Rectifier Bridge Checks and Removal

1. Set Analyzer selector switch on Scale No. 3 (Continuity) or V-O-A Tester on Scale Rx1.
2. Connect one test lead to grounded heat sink and one test lead to one of the 3 terminals. (Figure 10) Note reading on scale.
3. Reverse test leads and note reading on meter.
4. If both readings are zero, or both readings are very high, rectifier bridge is defective. A good rectifier will give one low reading and one high reading.
5. Repeat Steps 2-thru-4 between grounded heat sink and other 2 terminals and between insulated heat sink and each of the 3 terminals.

   NOTE: This makes a total of 6 checks, with 2 readings taken for each check.

6. Replace rectifier bridge, if defective.

Figure 11. Rectifier Bridge Checks

IMPORTANT: If rectifier bridge is constructed as shown in Figure 11, check in same manner, except, with the test lead, press down very firmly onto flat metal connector, not onto threaded stud.

STATOR

NOTE: Do not perform this check for an overcharged battery condition.

STATOR TEST for GROUND

1. Remove all 3 stator lead attaching nuts and separate stator assembly from end frame. Fit between stator frame and end frame is not tight and can be separated easily.
2. With Magneto Analyzer Selector switch on Scale No. 3 (Continuity) or, using V-O-A Testor on Scale Rx1, connect one test lead to any one of the 3 stator leads.
3. Place other lead from tester on stator frame. (Figure 12)
4. If meter hand on Analyzer or V-O-A moves to right, windings are grounded.

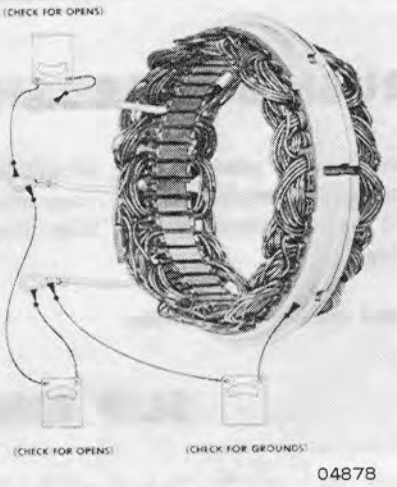

Figure 12. Checking Stator

STATOR TEST for OPEN CIRCUIT

1. Stator must be removed from end frame as described in "Disassembly" Step No. 4.
2. With Magneto Analyzer selector switch on Scale No. 3 (Continuity), or, using V-O-A Tester on Scale Rx1, connect tester leads successively between each pair of stator leads. (Figure 12)
3. If meter hand on Analyzer or V-O-A does not move to right, windings are open.

STATOR TEST for SHORT CIRCUIT

Because of low resistance of windings, a short circuit in stator windings is difficult to locate without laboratory test equipment. However, if all other electrical checks (following) are normal, and alternator fails to supply rated output, stator windings are shorted. Another possibility is a ground which exists between stator windings and either end frame before disassembly. Visually inspect very carefully for this possibility.

SUMMARY OF ALTERNATOR CHECKS

COMPONENT	CONNECTION	READING	RESULT
Rotor	1. Analyzer from Slip Ring to Shaft 2. Analyzer Across Slip Rings	Low High	Grounded Open
Stator (Disconnected from Diodes)	1. Analyzer from Lead to Frame 2. Analyzer Across Each Pair of Leads	Low High	Grounded Open
Diode Trio	Analyzer Across Diode, Then Reverse Connections	Both Readings Very Low Both Readings Very High	Shorted Open
Rectifier Bridge (Disconnected from Stator)	Analyzer Across Diode, Then Reverse Connections	Both Readings Very Low Both Readings Very High	Shorted Open

BRUSH and BRUSH HOLDER REPLACEMENT

1. If brushes are worn over 50 percent, they should be replaced. When brushes are replaced, slip rings also should be cleaned as explained under "Slip Ring Servicing", following.
2. Remove 3 screws and remove brush holder.
3. Unsolder brush lead from metal tab and solder new brush leads to tab.

   NOTE: Pin (inserted thru end frame and brush holder) retains brushes in holder.
4. Place brush assemblies in brush holders and install pin.

SLIP RING SERVICING

1. If slip rings are dirty, they may be cleaned and finished with 400 grain or finer polishing cloth. Spin rotor and hold polishing cloth against slip rings until they are cleaned.

CAUTION: Spin rotor so that slip rings will be cleaned evenly. To neglect spinning rotor may result in flat spots on slip rings, with subsequent brush noise. Support journal on a steady rest with rollers. Do not use "V" blocks, as they may damage journal.

2. Rough or out-of-round slip rings should be trued in a lathe to .002" (.051mm) maximum indicator reading. Remove only enough material to make rings smooth and round.
3. Finish with 400 grain or finer polishing cloth and blow away any dust.

BEARING REPLACEMENT

DRIVE END FRAME BEARING

1. Remove 3 bearing retainer plate screws.
2. Support frame on hollow cylinder and press bearing toward inside of frame until it is removed. Remove grease slinger.
3. Bearing may be re-used, if in satisfactory condition. Fill one-quarter full with Ball Bearing Lubricant (C-92-36204-1) before reassembly.

CAUTION: Do not overfill, as this may cause bearing to overheat.

4. Place new grease slinger in frame and press bearing in frame with tube or collar which just fits over outer race.
5. Fill cavity between retainer plate and bearing with Ball Bearing Lubricant.
6. If felt seal in retainer plate is hardened or worn, install new retainer plate assembly.

RING END FRAME BEARING

NOTE: If grease supply in end frame bearing is exhausted, replace bearing. DO NOT re-lubricate bearing.

1. Support inside of end frame on hollow cylinder to prevent breakage of end frame.
2. Press bearing toward inside of frame with mandrel which just fits inside end frame housing. Carefully note assembly of seals for reassembly in same manner.
3. Place bearing on frame and press into position with mandrel (from outside toward inside of frame) until bearing is flush with outside of end frame.
4. Support inside of frame with a hollow cylinder to prevent breakage of end frame.

CAUTION: Use extreme care to avoid misalignment or placing undue stress on bearing.

5. Replace seal by pressing seal in with lip of seal toward inside of end frame.
6. Lightly coat seal lip with oil to facilitate assembly of shaft into bearing.

REASSEMBLY

INSTALLING SLIP RING END FRAME and BRUSH ASSEMBLY

NOTE: Before reassembly magnetize rotor field winding by connecting positive (+) post of a 12-volt battery to edge of outer slip ring and negative (-) post to inside slip ring nearest to field winding.

1. When assembling pulley, secure rotor in a vise only tight enough to permit torquing shaft nut to 40-60 ft. lbs. (5.5-8.3mkg). If excessive pressure is applied against rotor, assembly may become distorted.
2. To install slip ring end frame assembly to rotor and drive end frame assembly, remove tape over bearing and shaft and make sure that shaft is perfectly clean after removing tape.
3. Insert a pin through holes to hold up brushes.
4. Carefully install shaft into slip ring end frame assembly to avoid damage to seal.
5. After tightening thru bolts, remove brush retaining pin to allow brushes to fall down onto slip rings.

REPLACEMENT ALTERNATOR INSTALLATION

NOTE: When installing replacement alternator, be sure to mount unit so that slip ring end frame and brush assembly is located in same position as on replaced unit. This may require that end frame be rotated on new unit by loosening thru bolts and rotating end frame either 90° or 180°. Replace thru bolts.

CAUTION: Avoid separating alternator further than necessary, so that brushes will not drop off slip ring. If this happens, remove brush holder, clean slip ring and reinstall brush holder as explained under "Slip Ring Servicing" and "Brush Replacement".

1. Install bolt, spacer and nut which fasten alternator to support brackets.
2. Swing alternator toward engine and place drive belt on pulley.
3. Install mounting brace bolt and washer, but do not tighten belt.
4. Adjust belt tension by depressing belt midway between water pump pulley and alternator pulley with strand tension gauge.
5. Adjust alternator on its mounting bracket until belt tension is sufficient to read 45 lbs. Tighten brace bolt securely.

NOTE: In emergency, tension may be adjusted by depressing belt with thumb midway between water pump pulley and alternator pulley. Belt should not depress more than ½" (12.7mm).

DIRECT DRIVE ALTERNATOR SYSTEM for 60, 80 and 90

DESCRIPTION

The direct drive alternator does not have brushes, pulleys, belts or extra bearings, hence, it offers almost complete freedom from service repairs and/or maintenance.

Stator windings are assembled on a laminated core which is secured to the timing chain cover. Permanent magnets (located in the flywheel) rotate around the stationary stator to produce alternating current. A separately-mounted diode rectifier changes alternators A.C. current to D.C.

COMPONENTS

Alternator system includes battery, alternator, rectifier and necessary wiring to connect these components.

PRECAUTIONS

Alternator and rectifier are designed only for negative polarity systems. Following precautions must be observed. Failure to observe these precautions will result in serious damage to alternator and/or rectifier.

1. When installing a battery, always be certain that negative (-) terminal of battery is grounded.
2. When connecting a booster battery, be sure to connect plus-to-plus and minus-to-minus battery terminals. Never connect in series.
3. When connecting a charger to battery, connect plus and minus charger leads to the plus (+) and minus (-) battery terminals. Rectifier diodes may burn out if leads are reversed.
4. Never operate alternator on open circuit. Be certain that all connections in circuit are secure.
5. Do not short across or ground any terminal on alternator or rectifier.
6. Do not attempt to polarize alternator.

INSPECTION

At periodic intervals (determined largely by type of operating conditions), inspect battery, alternator, rectifier and wiring as follows:

1. Check terminals for corrosion and loose connections.
2. Inspect wires for frayed and worn insulation.
3. Check mounting bolts for tightness.

TROUBLESHOOTING

Trouble in charging system will show up as one or more of the following conditions:

1. An undercharged battery, as indicated by slow cranking and low specific gravity.
2. An overcharged battery, as indicated by excessive water usage.

UNDERCHARGED BATTERY

Slow cranking and low specific gravity readings may be caused by one or more of the following conditions:

1) Disconnect internal wiring harness from electrical components.
2) Check for continuity between any of wires in harness with Magneto Analyzer (Scale No. 3). If continuity exists, repair or replace harness.

SHORT TEST

1. Ensure that undercharged condition has not been caused by accessories turned on for extended periods.
2. Check battery for defects and replace if found defective.
3. Inspect wiring for shorts or open circuit.

RESISTANCE TEST

1) Turn Magneto Analyzer selector switch to position No. 2 (Distributor Resistance) and clip small red and black leads together.
2) Turn meter adjustment knob for Scale No. 2 until meter pointer lines up with set position on left side of "OK" block on Scale No. 2.
3) Unclip small red and black leads.
4) Using wiring diagram as a guide, check each wire for resistance between harness connection and terminal ends.
5) If resistance exists, repair or replace harness.

INSTRUMENT PANEL WIRING HARNESS

Instrument panel wiring harness is checked in same manner as engine wiring harness. Use wiring diagrams as a guide.

4. Check all connections for tightness and corrosion. Clean as required.
5. Connect V-O-A (0-20 volt scale) from red terminal (red-and-white terminal on "80") on rectifier to ground.

Zero reading indicates an open between rectifier and battery.

6. Check field relay in regulator for proper operation. Replace if defective.
7. If previous steps check satisfactorily, perform alternator system output check, following.

ALTERNATOR SYSTEM OUTPUT CHECK

MERCRUISER 60

IMPORTANT: Do not attempt to check charging system in any manner other than described below, as alternator and/or diode rectifier may be damaged.

1. Disable ignition system by removing coil high tension lead from center of distributor cap and ground this lead to engine block.
2. Disconnect positive (red) output lead from rectifier and connect test ammeter (20-0-20) in series with positive output lead and positive output terminal on rectifier.
3. Operate starter 10 to 15 seconds to remove battery surface charge.
4. Reinstall high tension lead in distributor cap.
5. Start engine and accelerate to 3000 RPM. While accelerating, observe maximum reading on text ammeter. Reading must be 11 amps.
6. If amperage reading is below 11 amps, check alternator system components to determine cause.
7. After repairing alternator system, complete test procedure once again to assure proper operation.

MERCRUISER 80-90

1. Disconnect blue alternator stator lead from blue voltage regulator lead.

NOTE: Prevent leads from grounding.

2. Remove red/white lead from rectifier and connect test ammeter (30-0-30 minimum) between lead and rectifier terminal.
3. Start engine and accelerate to 3000 RPM. Test ammeter should show 18 to 25 amps. Following conditions may exist:
   a. Total of 18 to 25 amps are present, but battery is undercharged. Check wiring to regulator. If wiring checks OK, replace regulator.
   b. Total of 18 to 25 amps are not shown; test rectifier. If rectifier tests OK, perform resistance check on stator. If rectifier tests unsatisfactory, replace rectifier and repeat test.

OVERCHARGED BATTERY

Check Battery. Remember that an overheated battery will be overcharged even though no charging circuit defects are present.

MERCRUISER 80-90

If obvious overcharge condition exists (as indicated by excessive battery water usage) and, if battery is not overheated and not defective, 2 conditions may be present:

1. Stator operation is abnormal.
2. Regulator not functioning properly.

Perform following test to find abnormal component:

Ground blue stator lead. If output drops to zero, regulator is bad. If output does not drop to zero, stator is bad.

REMOVAL

RECTIFIER

1. Disconnect leads from rectifier terminals.
2. Remove rectifier hex head mounting bolt.
3. Remove rectifier.

STATOR

Refer to Section 8, "Engine Mechanical," for stator removal.

DISASSEMBLY

RECTIFIER

Do not attempt to disassemble rectifier. If defective, replace.

STATOR

Stator is located inside flywheel housing. Remove 4 mounting bolts and remove stator.

COMPONENT CHECKS

RECTIFIER

1. Turn Magneto Analyzer selector switch to position No. 3 (Coil Continuity) and connect small red and black test leads together.
2. Turn meter adjustment knob for Scale No. 3 until meter pointer lines up on right side (set position).
3. Testing positive diodes
   a. Connect small red test lead to either alternator terminal and connect black lead to positive terminal

to rectifier. (Figure 3) Meter pointer should move to right of Scale No. 3.

b. Reverse test leads on rectifier. Meter pointer should remain stationary at left side of Scale No. 3.

c. Repeat Steps "a" and "b" on opposite alternator terminal. This will determine condition of positive diodes.

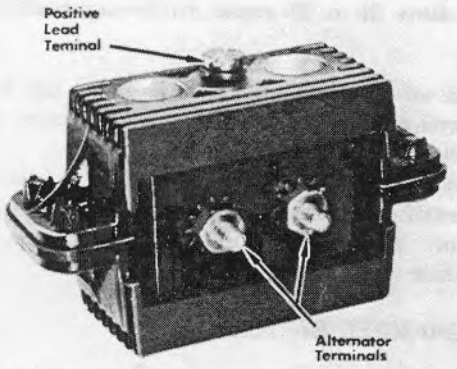

Figure 3. Testing Positive Diodes

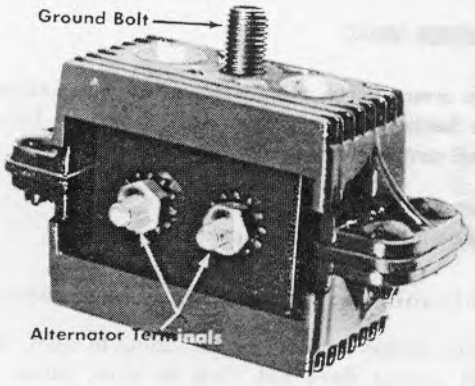

Figure 4. Testing Negative Diodes

4. Testing negative diodes
   a. Connect small red test lead to either alternator terminal and connect black test lead to rectifier ground stud. (Figure 4) Meter pointer should remain stationary at left side of Scale No. 3.
   b. Reverse test leads on rectifier. Meter pointer should move to right side of Scale No. 3.
   c. Repeat Steps "a" and "b" on opposite alternator terminal. This will determine condition of negative diodes.

NOTE: If any diode does not check OK, rectifier is defective and must be replaced.

5. Connect small red and black test leads to terminals of yellow alternator leads.
6. For MerCruiser 60, meter should indicate between .35 to .45 ohms on Scale No. 2.
7. Replace alternator stator if it does not meet above specifications.

ALTERNATOR STATOR for MERCRUISER 80-90

1. Perform Steps 1-thru-4 of MerCruiser 60 alternator stator test immediately preceding.
2. Connect small red and black test leads, as indicated, and read following ohms:
   a. Red 1 to Red 2 reads .10 to .50 ohms
   b. Red 1 to Blue reads 1.5 to 1.9 ohms
   c. Red 2 to Blue reads 1.7 to 2.0 ohms
   d. Red 1 to Ground reads open
   e. Red 2 to Ground reads open
   f. Blue to Ground reads open
3. Replace alternator stator if it does not meet above specifications.

CAUTION: Do not attempt to check polarity of battery leads by "sparking" lead terminals against battery terminals. This action may result in a burned-out rectifier.

NOTE: Burned-out rectifiers are greatly discolored and/or have a "baked" appearance. Unless condition, which caused failure, is corrected, new rectifier will provide no better service than old rectifier.

ALTERNATOR STATOR for MERCRUISER 60

1. Alternator stator may be tested without removing flywheel.
2. Disconnect 2 yellow or red alternator leads from rectifier.
3. Turn selector switch of Magneto Analyzer to position No. 2.
4. Turn No. 2 meter adjustment knob to adjust meter scale needle with red line on right side of Scale No. 2.

SUMMARY OF ALTERNATOR CHECKS

COMPONENT	CONNECTION	READING	RESULTS
Rectifier Positive Diodes	Either Alternator Terminal to Positive Terminal	Low	Shorted
	Reverse Leads	High	Open
	Opposite Alternator Terminal to Positive Terminal	Low	Shorted
	Reverse Leads	High	Open
Negative Diodes	Either Alternator Terminal to Ground Stud	High	Open
	Reverse Leads	Low	Shorted
	Opposite Alternator Terminal to General Stud	High	Open
	Reverse Leads	Low	Shorted
Stator MerCruiser 60	Yellow Lead to Yellow Lead	.35 to .45 ohm	Good
MerCruiser 80-90	Red 1 to Red 2	.10 to .50 ohm	Good
	Red 1 to Blue	1.5 to 1.9 ohm	Good
	Red 2 to Blue	1.7 to 2.0 ohm	Good
	Red 1 to Ground	High	Open
	Red 2 to Ground	High	Open
	Blue to Ground	High	Open

REASSEMBLY

Reassembly, throughout, is the reverse order of disassembly.

SECTION 3 - ELECTRICAL SYSTEM

MERCRUISER

PART D -

NOTICE

This PART is for the Electrical System Section and will be used as new electrical systems or components become available.

MERCURY MARINE

SECTION 3 - ELECTRICAL SYSTEM

MERCRUISER

PART D -

NOTICE

This PART is for the Electrical System Section and will be used as new electrical systems or components become available.

SECTION 3 - ELECTRICAL SYSTEM

MERCRUISER

PART E - WIRING DIAGRAMS

MERCURY MARINE

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Engine Wiring Diagram - MerCruiser Inboard 350 (Serial No. 3780450 and Up) 3E-35

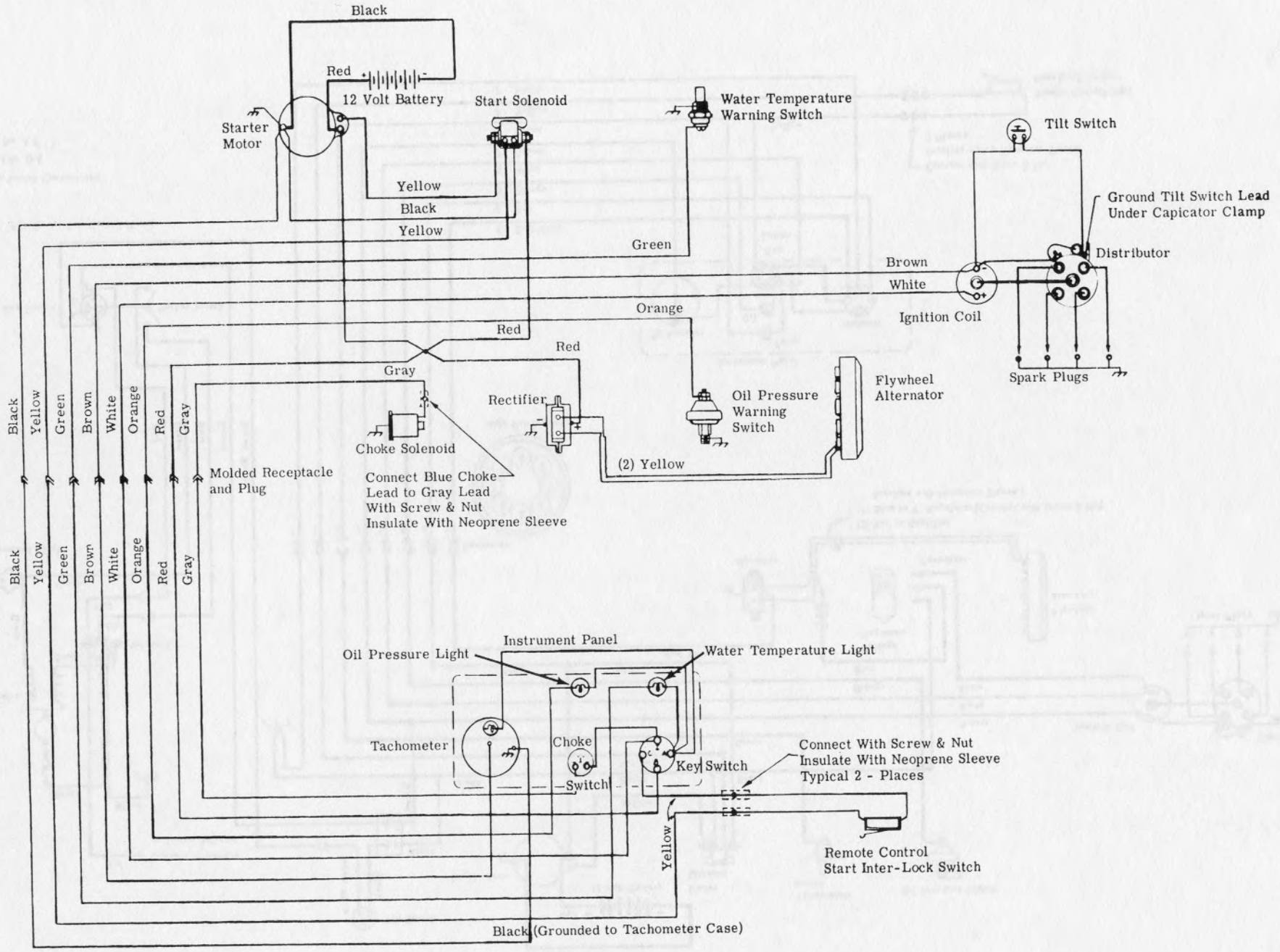


Figure 1. Engine Wiring Diagram - MerCruiser 60

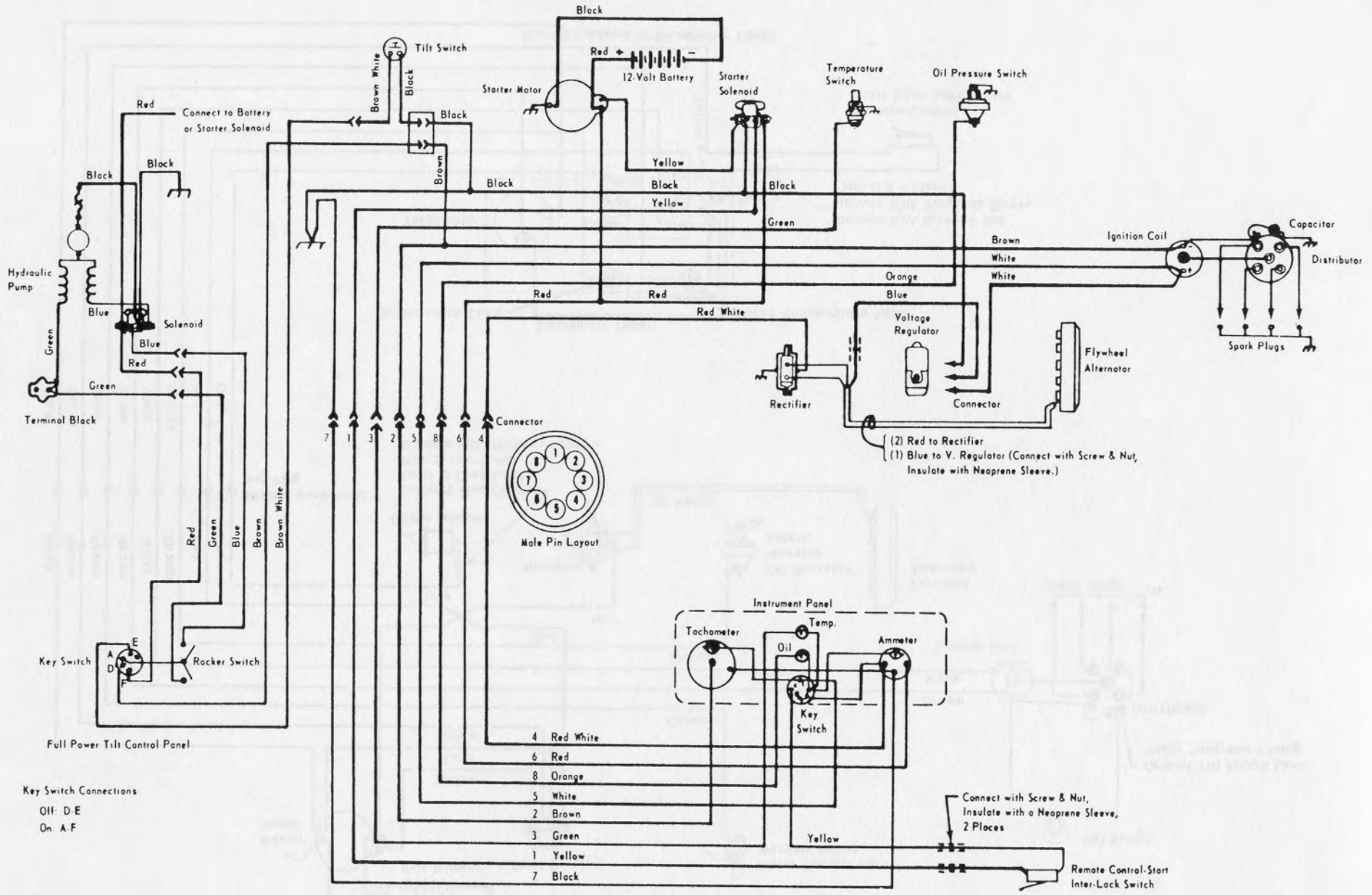


Figure 2. Engine Wiring Diagram - MerCruiser 80

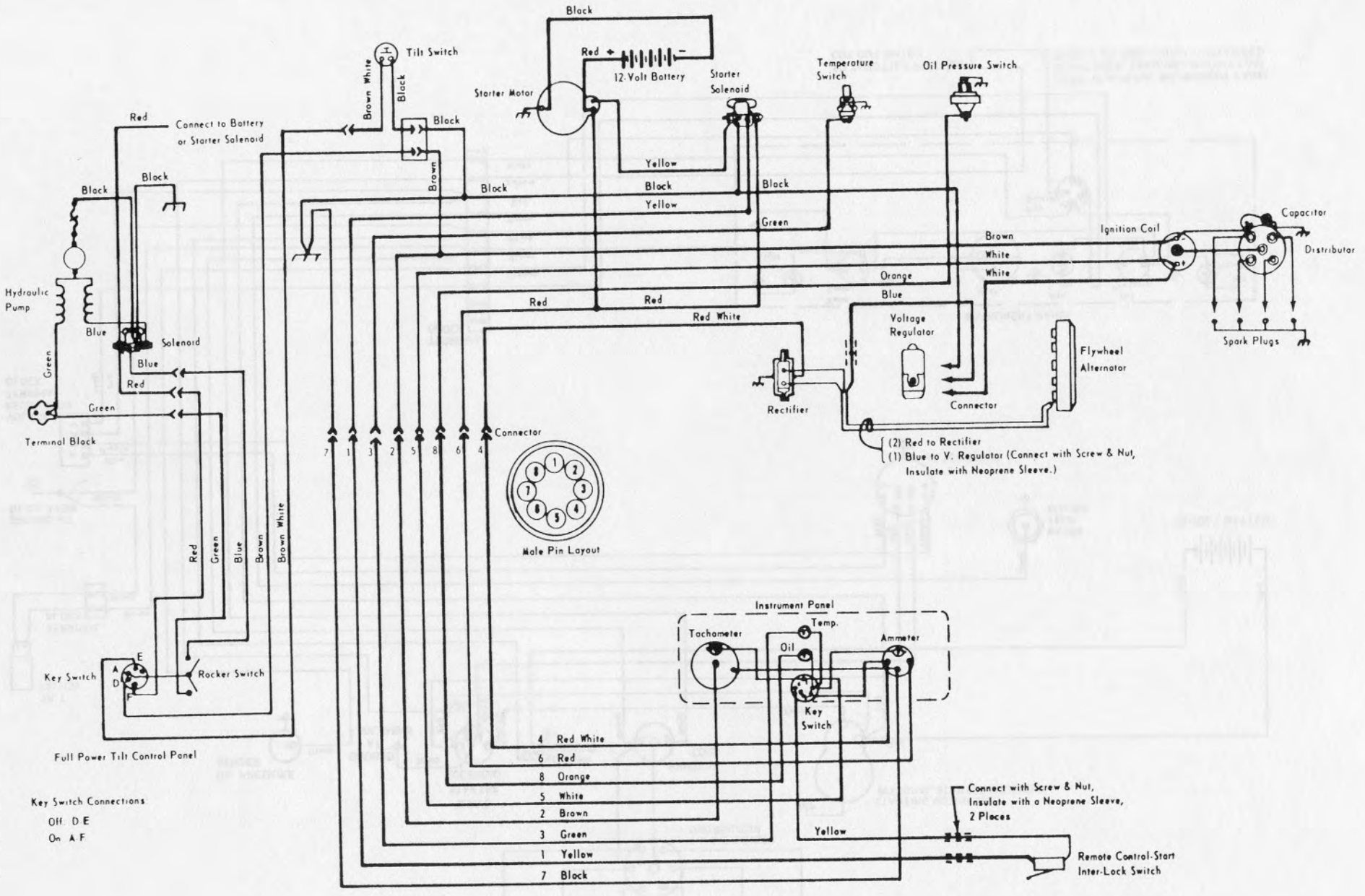


Figure 3. Engine Wiring Diagram - MerCruiser 90

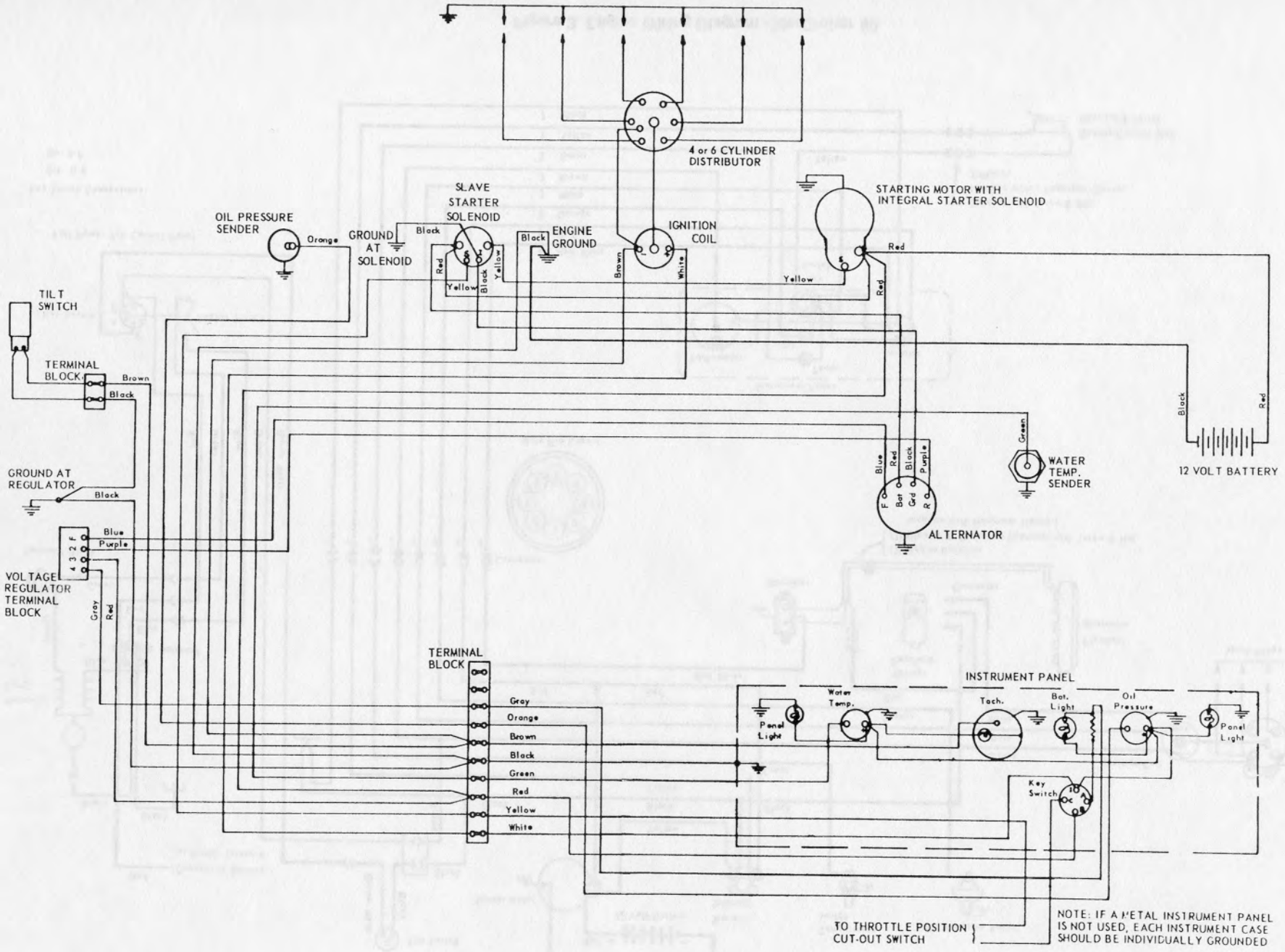


Figure 4. Engine Wiring Diagram - MerCruiser 110 and 140 (6-Cyl.) with Indicator Light

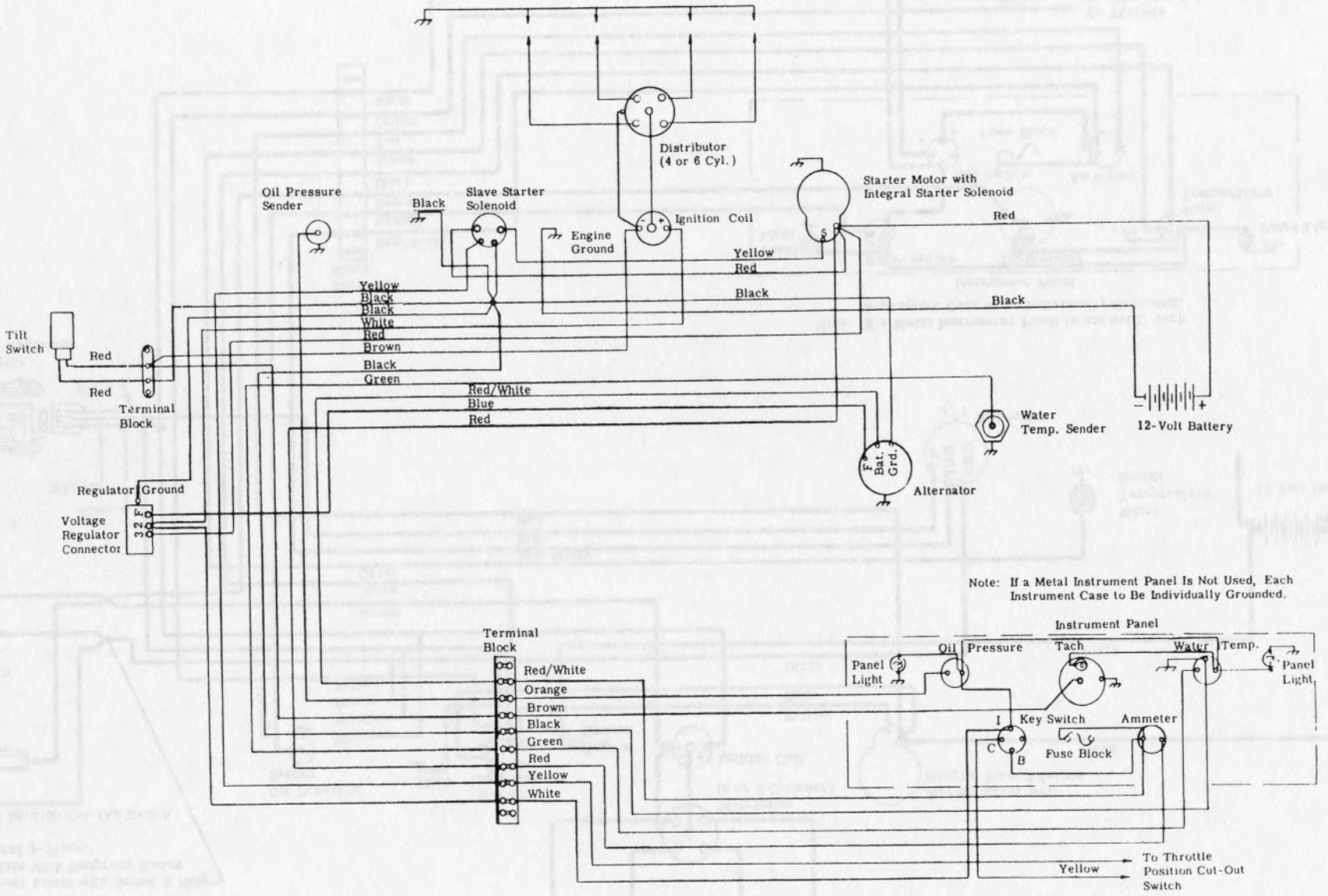


Figure 5. Engine Wiring Diagram - MerCruiser 110, 120, 140 (4-Cyl.) and 150 with Ammeter and Relay Regulator

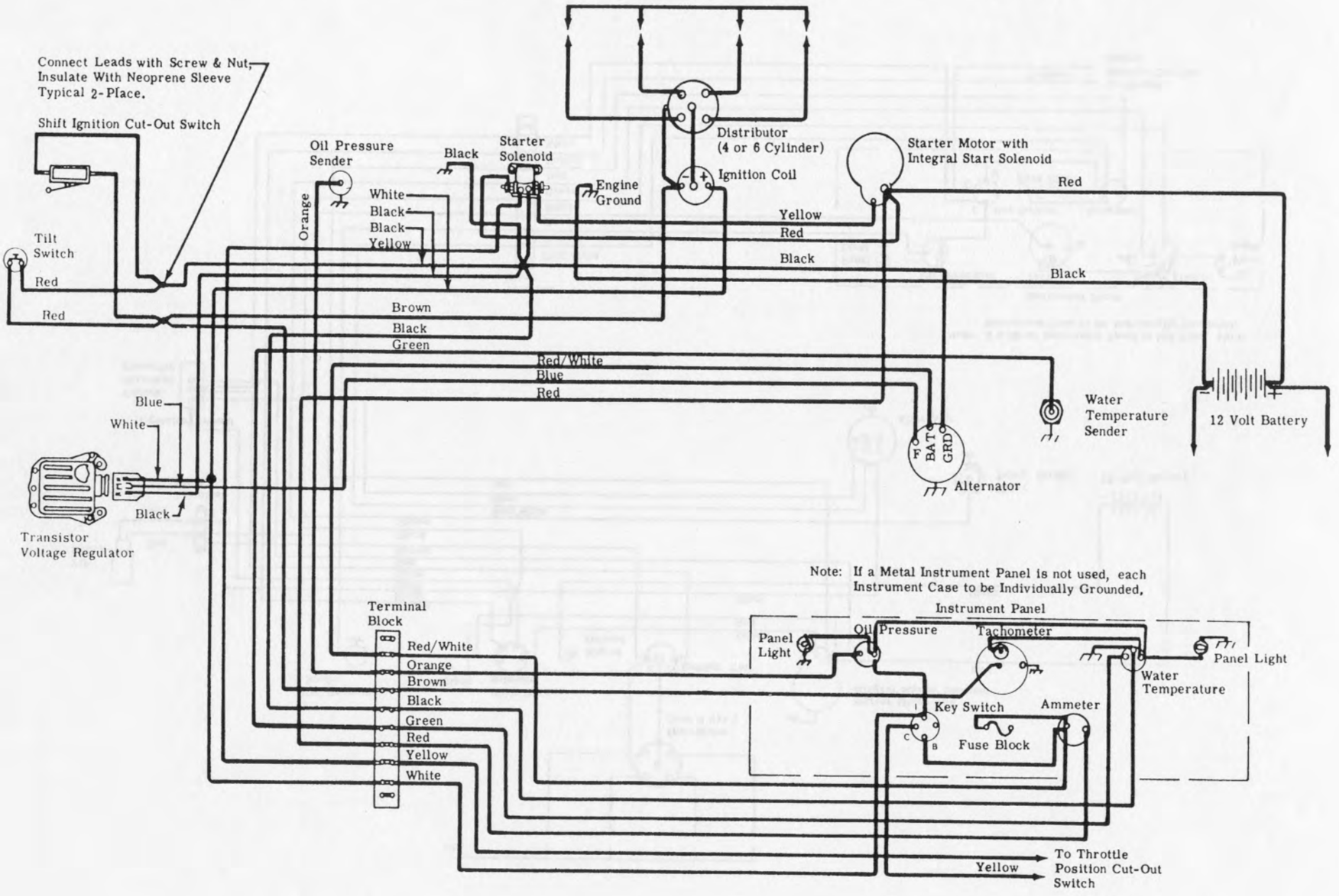


Figure 6. Engine Wiring Diagram - MerCruiser 110, 120 and 150 with Ammeter and Transistor Regulator

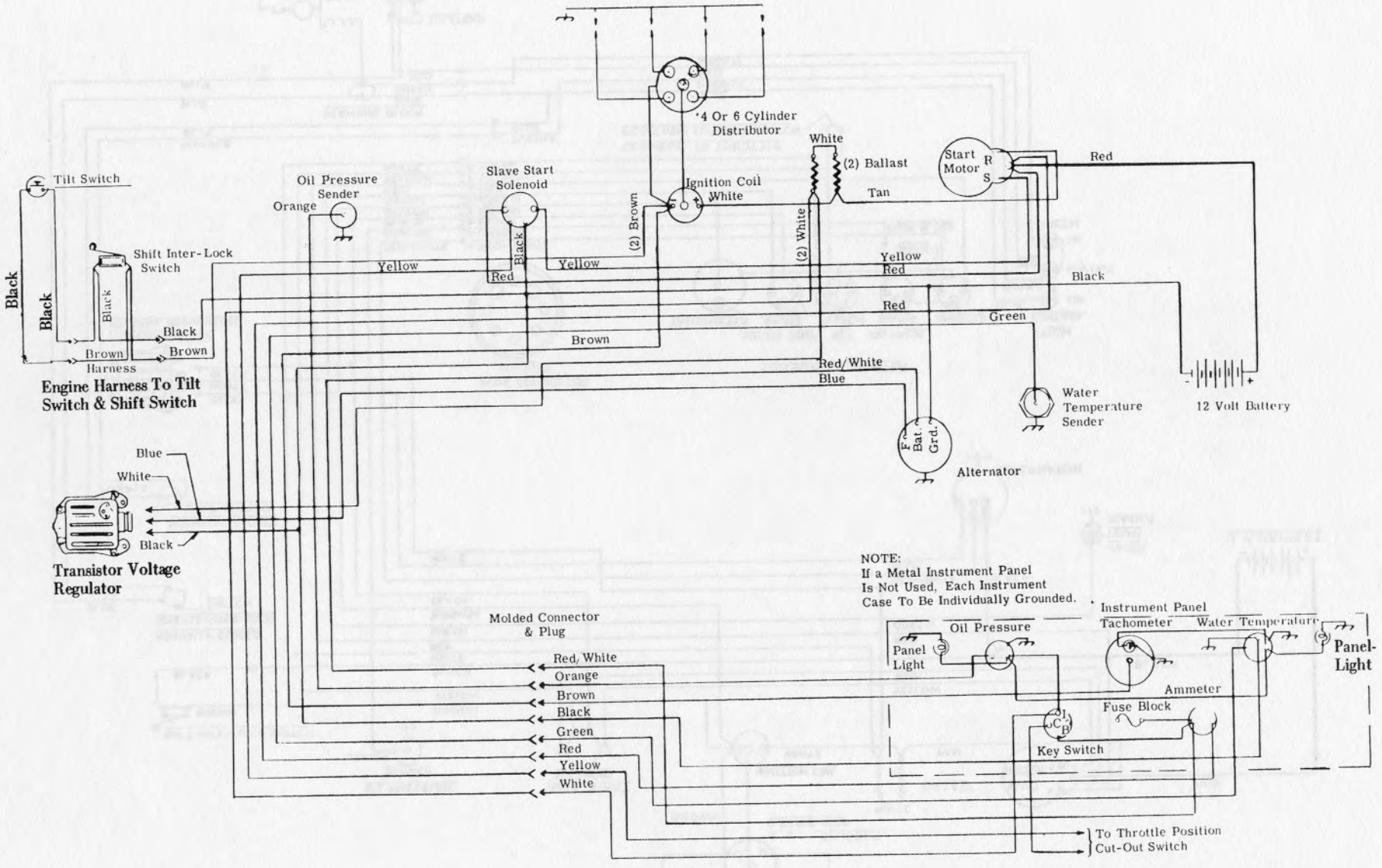


Figure 7. Engine Wiring Diagram - MerCruiser 110, 140 (4-Cyl.) and 150 with Ammeter, Transistor Regulator and Ballast Resistors

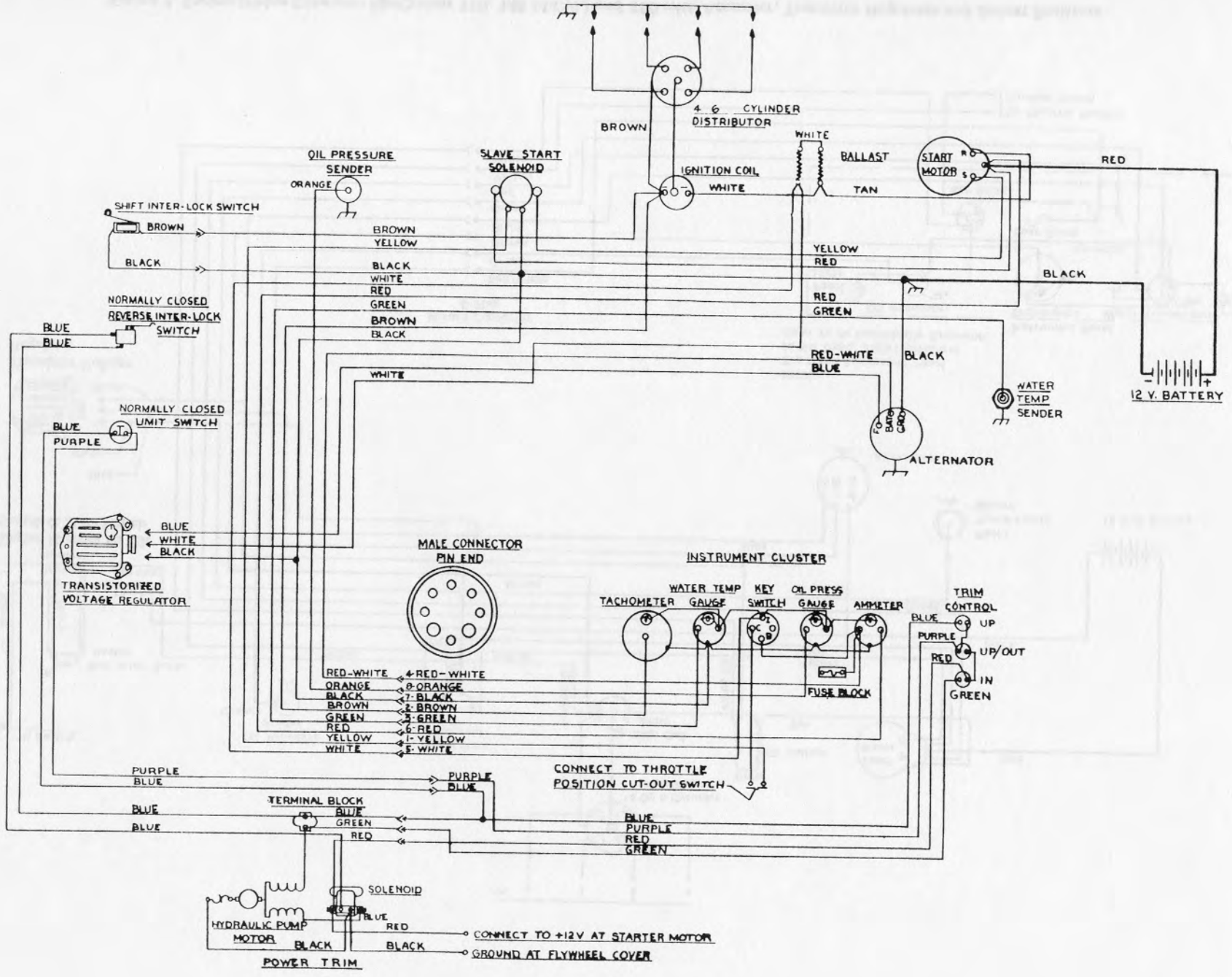


Figure 8. Engine Wiring Diagram - MerCruiser 140 with Transistor Regulator

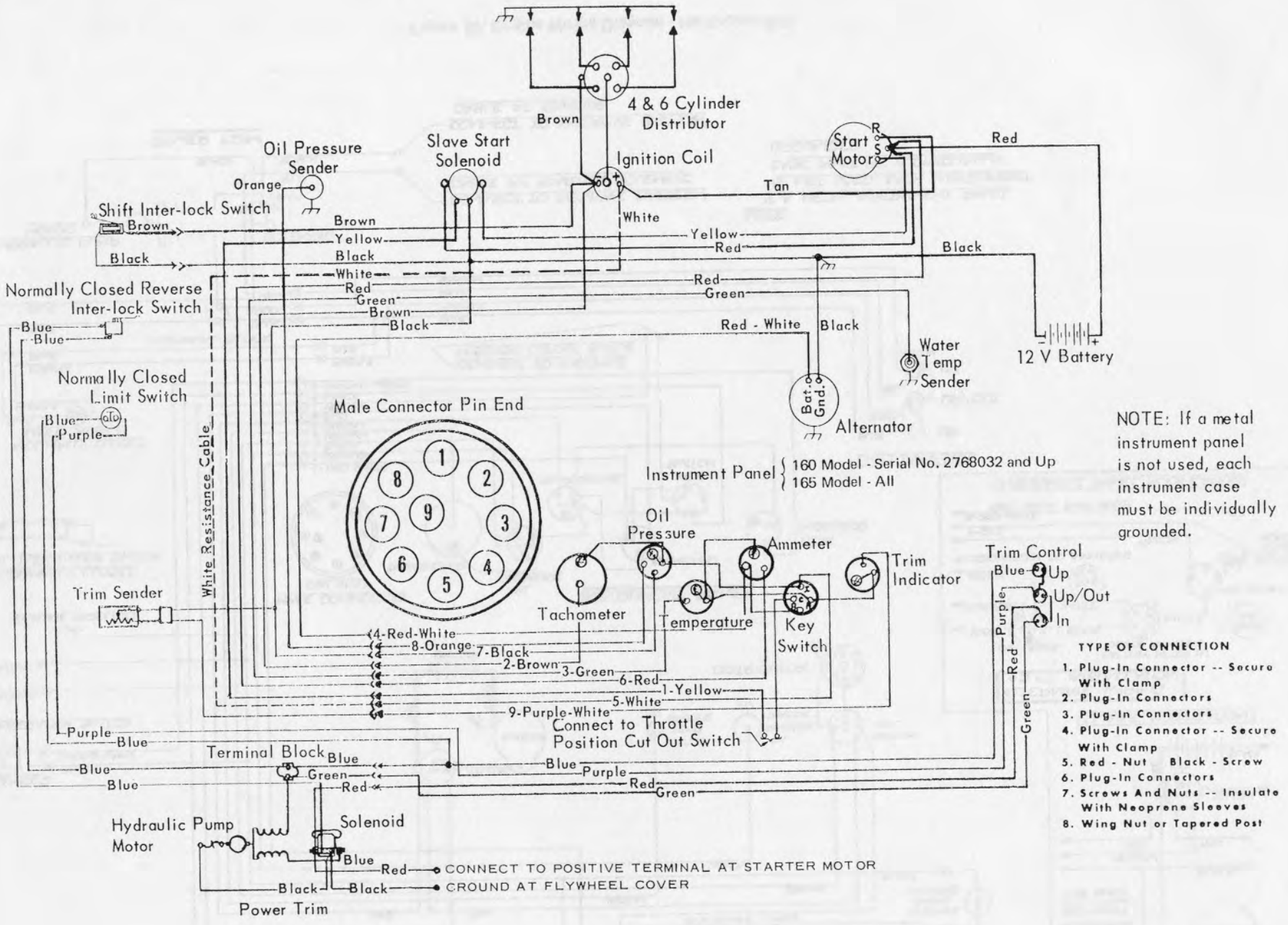


Figure 9. Engine Wiring Diagram - MerCruiser 160 and 165 with Integral Alternator

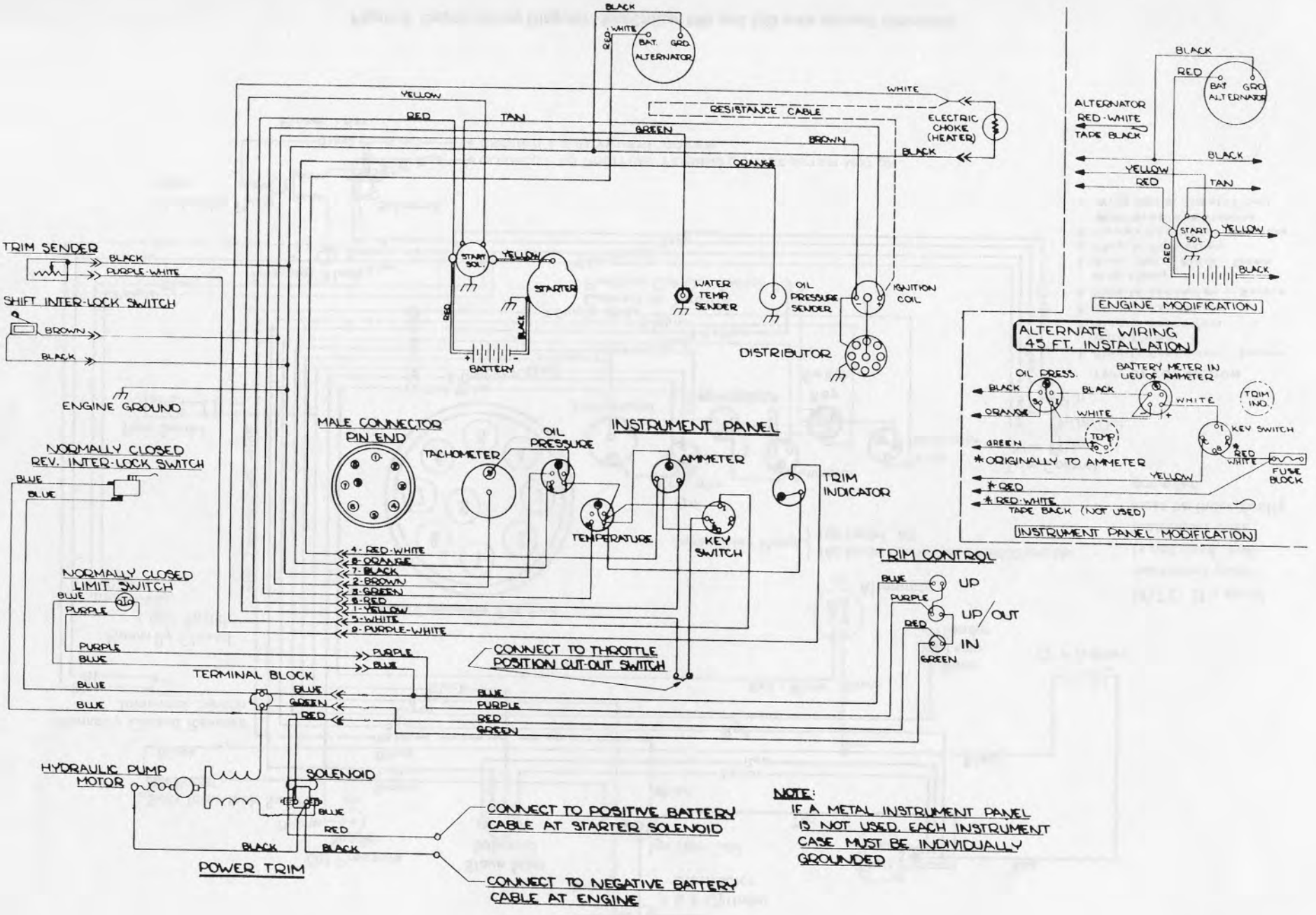


Figure 10. Engine Wiring Diagram - MerCruiser 888

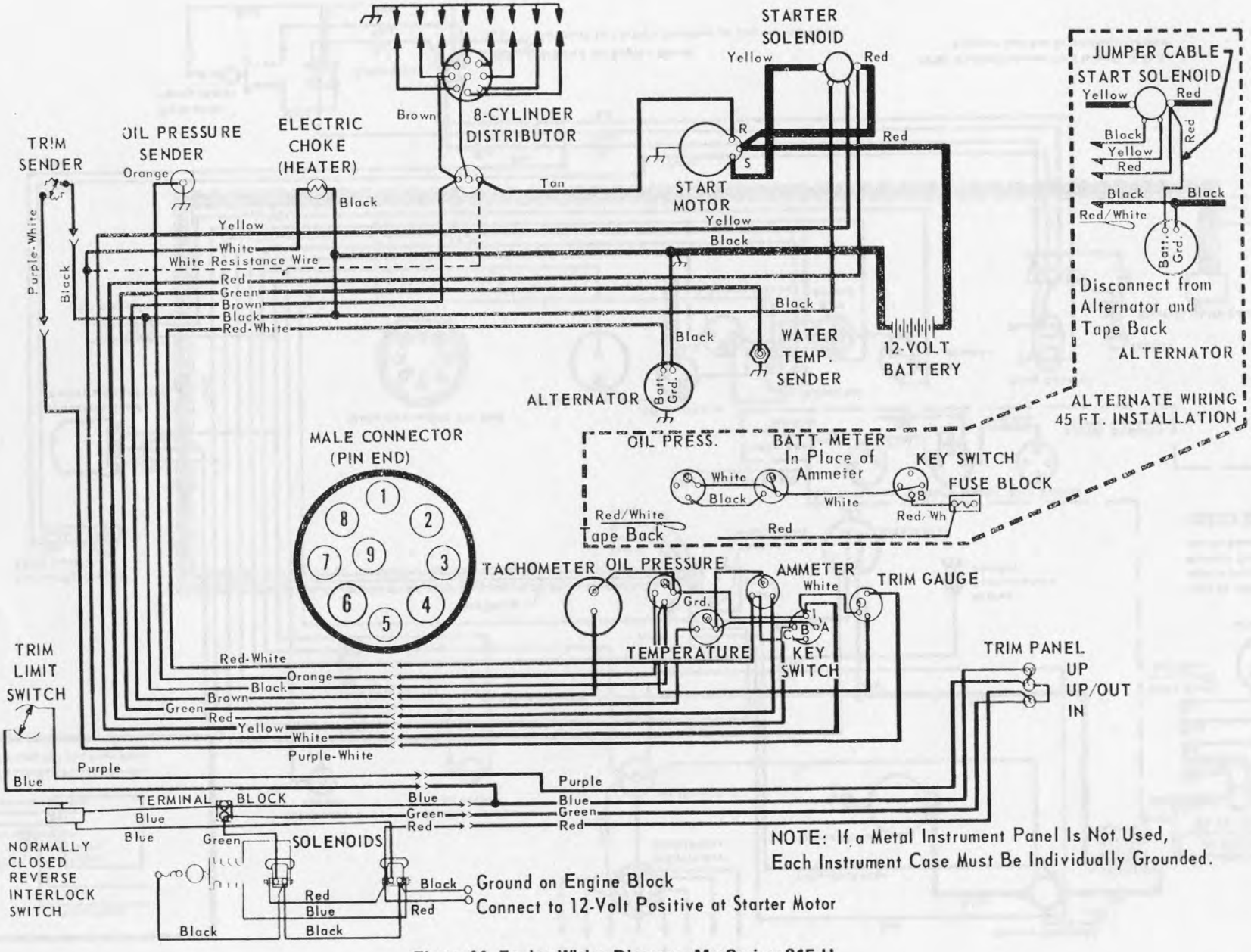


Figure 11. Engine Wiring Diagram - MerCruiser 215-H

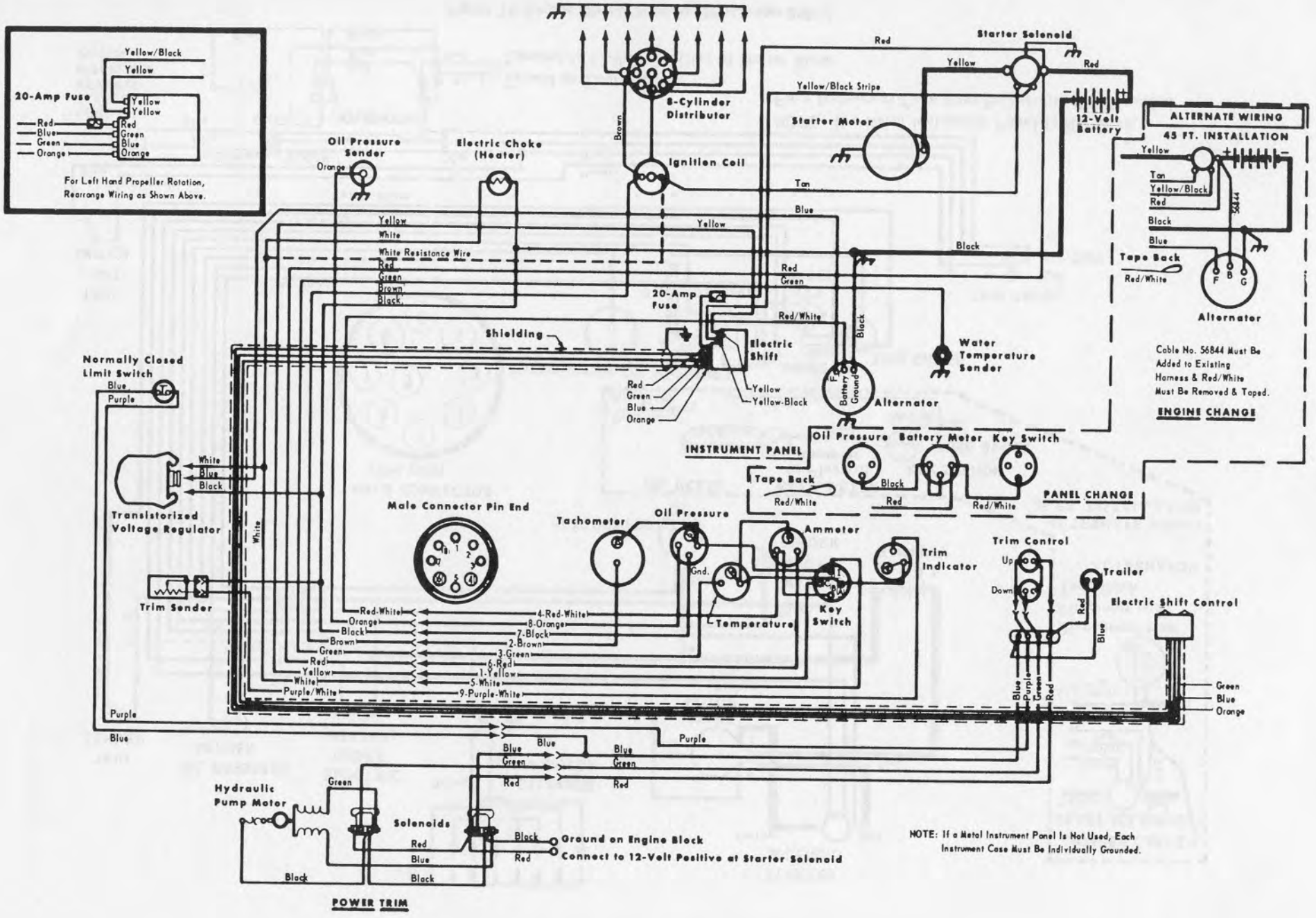


Figure 12. Engine Wiring Diagram - MerCruiser 215-E

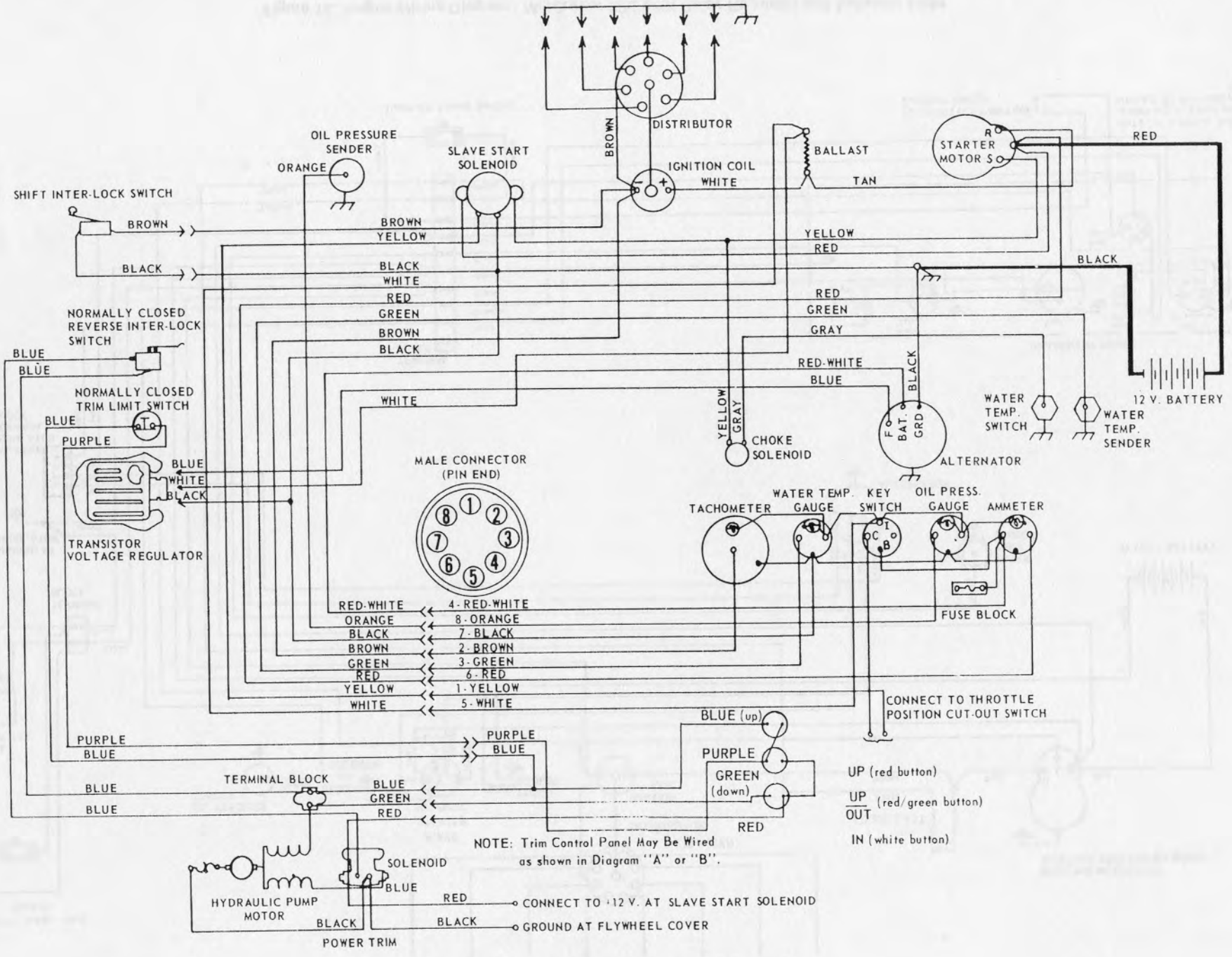


Figure 13. Engine Wiring Diagram - MerCruiser 200

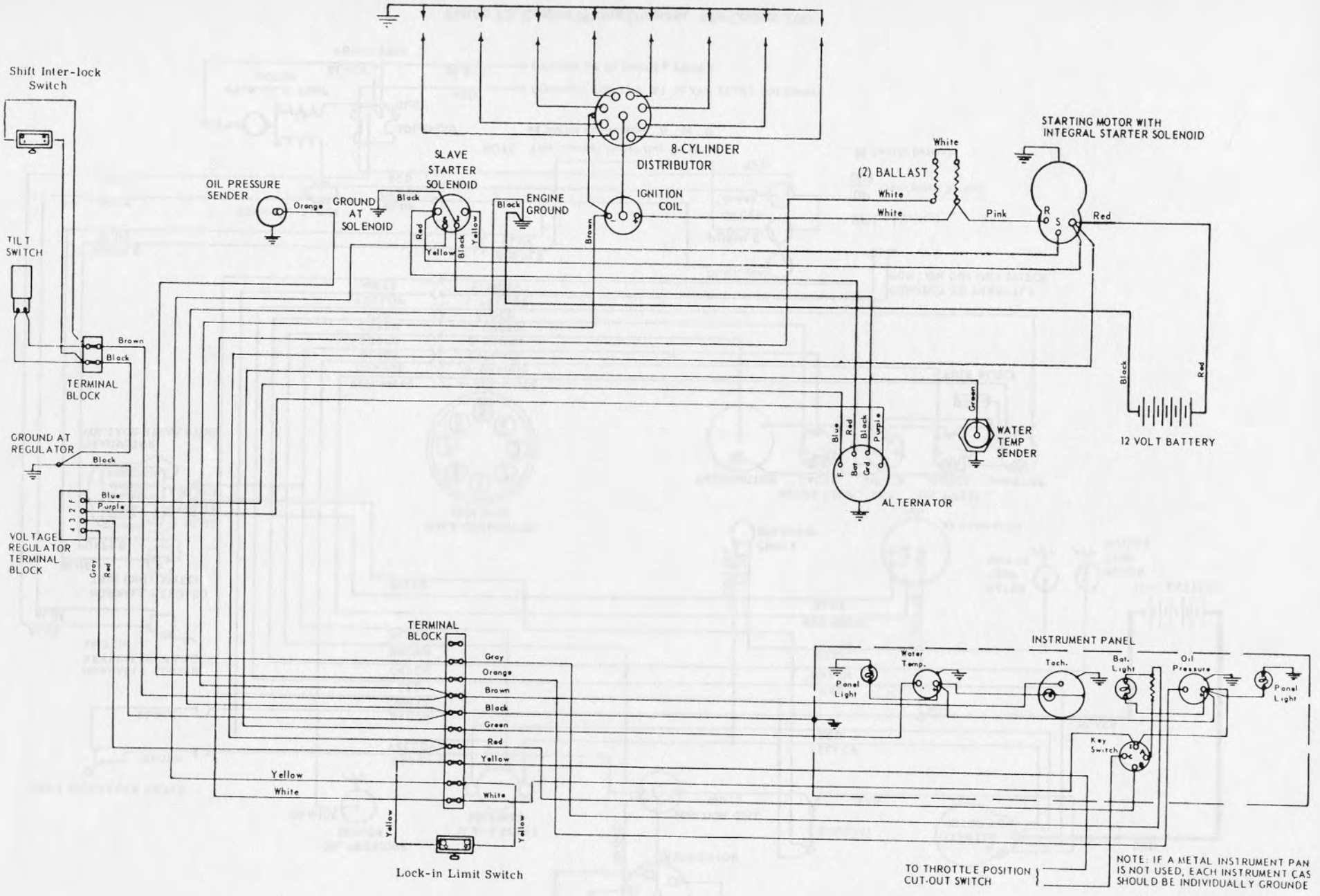


Figure 14. Engine Wiring Diagram - MerCruiser 225 with Relay Regulator and Indicator Light

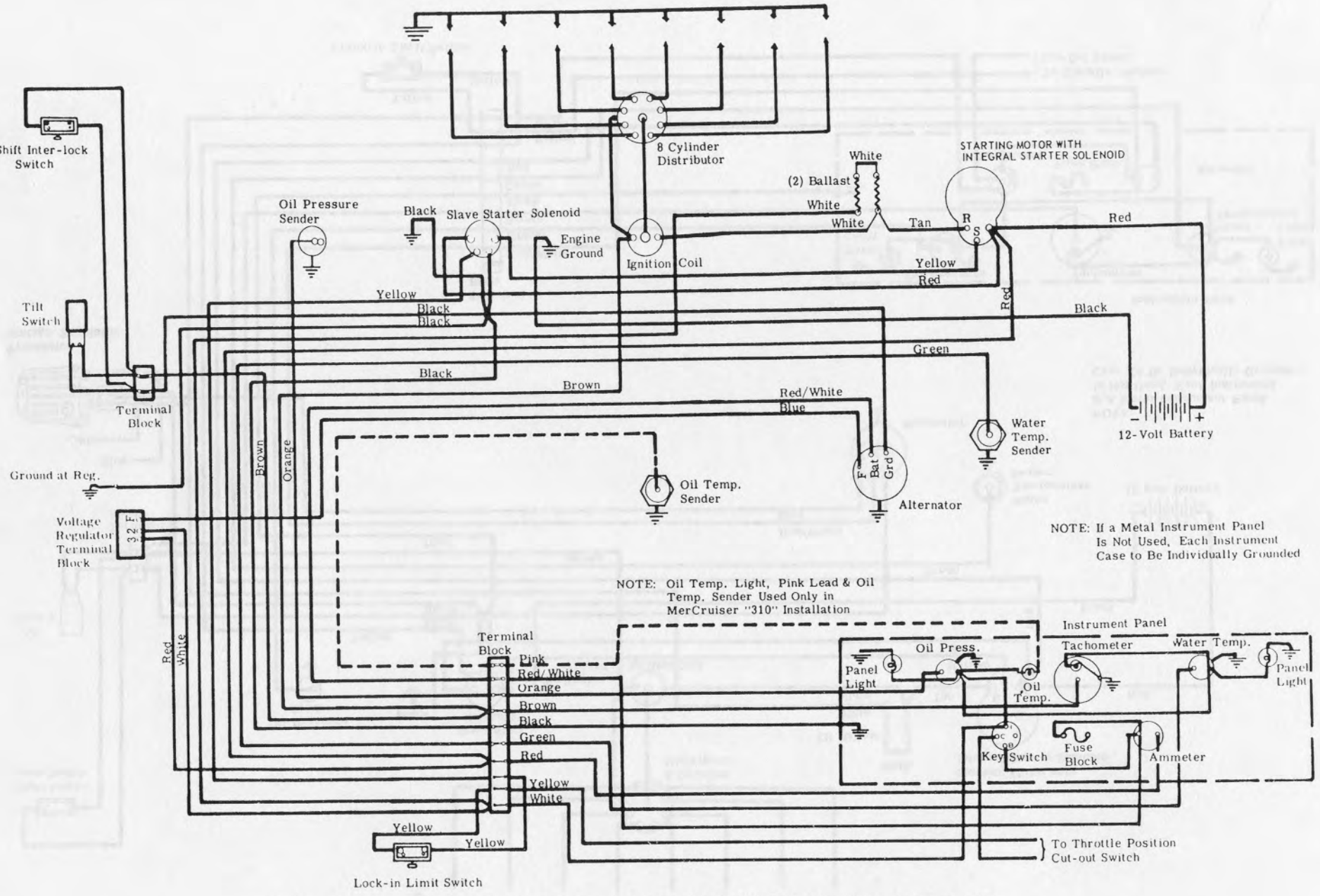


Figure 15. Engine Wiring Diagram - MerCruiser 190 and 225 with Relay Regulator and Ammeter

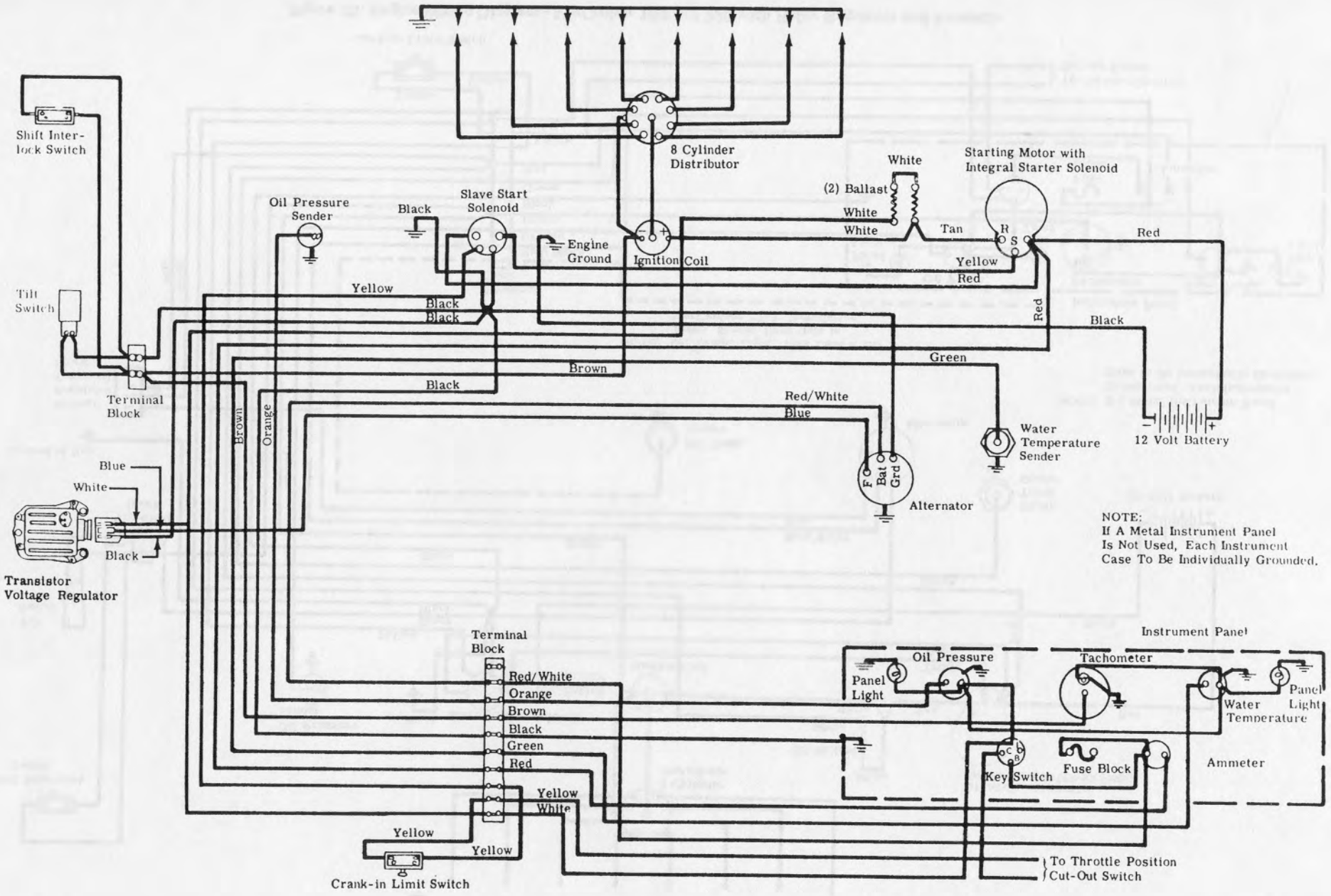


Figure 16. Engine Wiring Diagram - MerCruiser 225 with Transistor Regulator

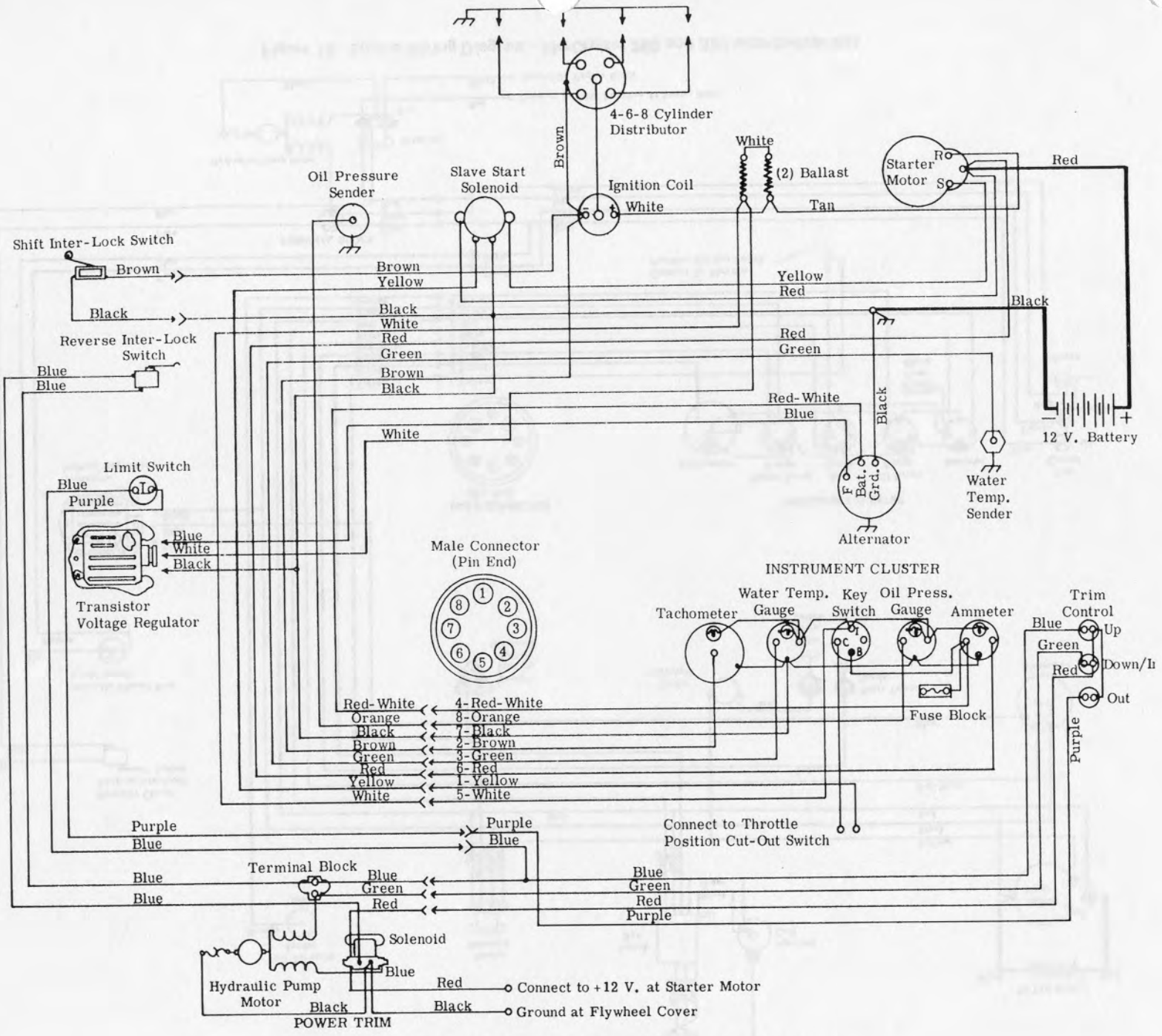


Figure 17. Engine Wiring Diagram - MerCruiser 225 with Electric Choke

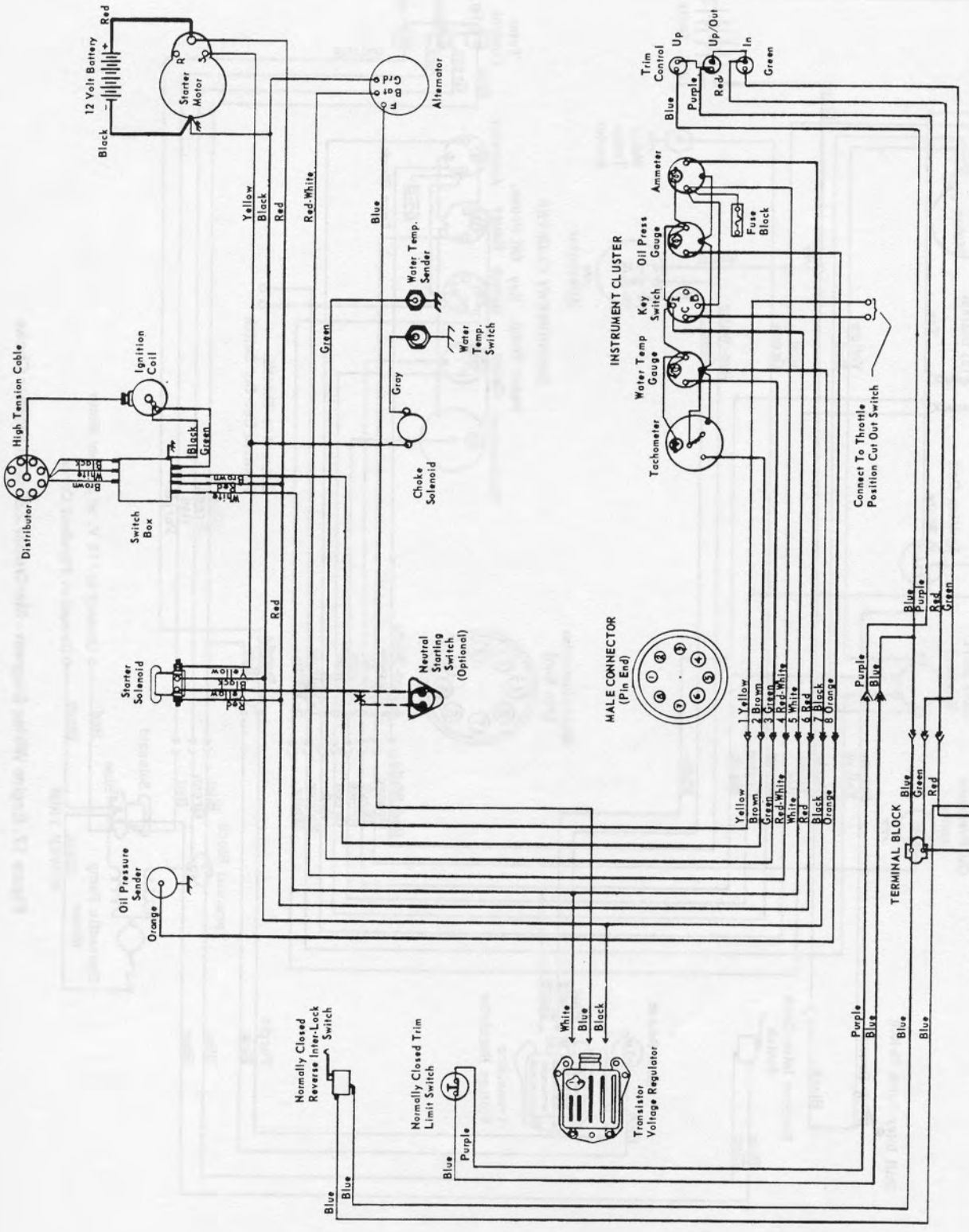


Figure 18. Engine Wiring Diagram - MerCruiser 250 and 325 with Switch Box

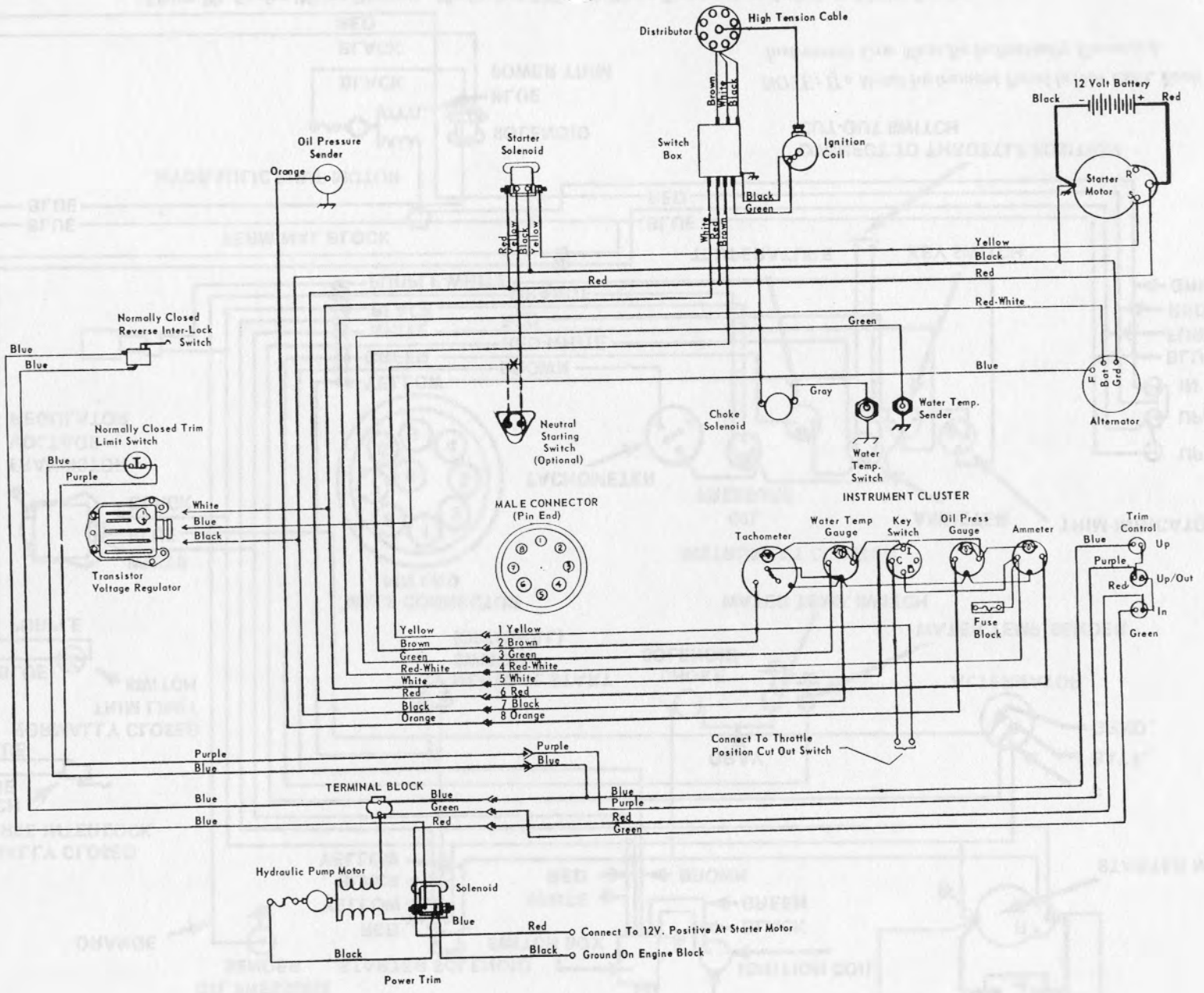


Figure 19. Engine Wiring Diagram - MerCruiser 250 and 325 with Water Temperature Switch

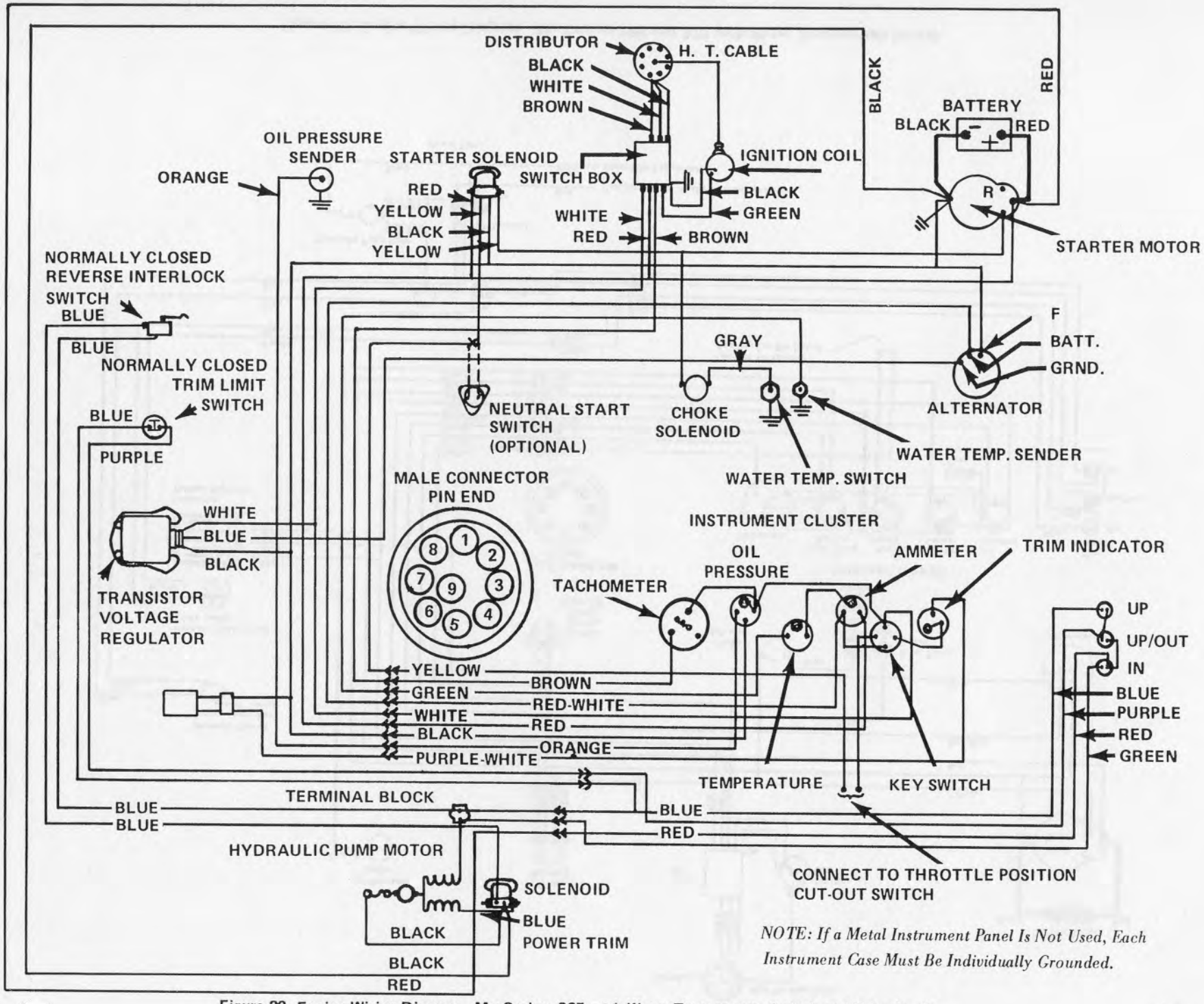


Figure 20. Engine Wiring Diagram - MerCruiser 325 ...h Water Temperature Switch and Trim Sender

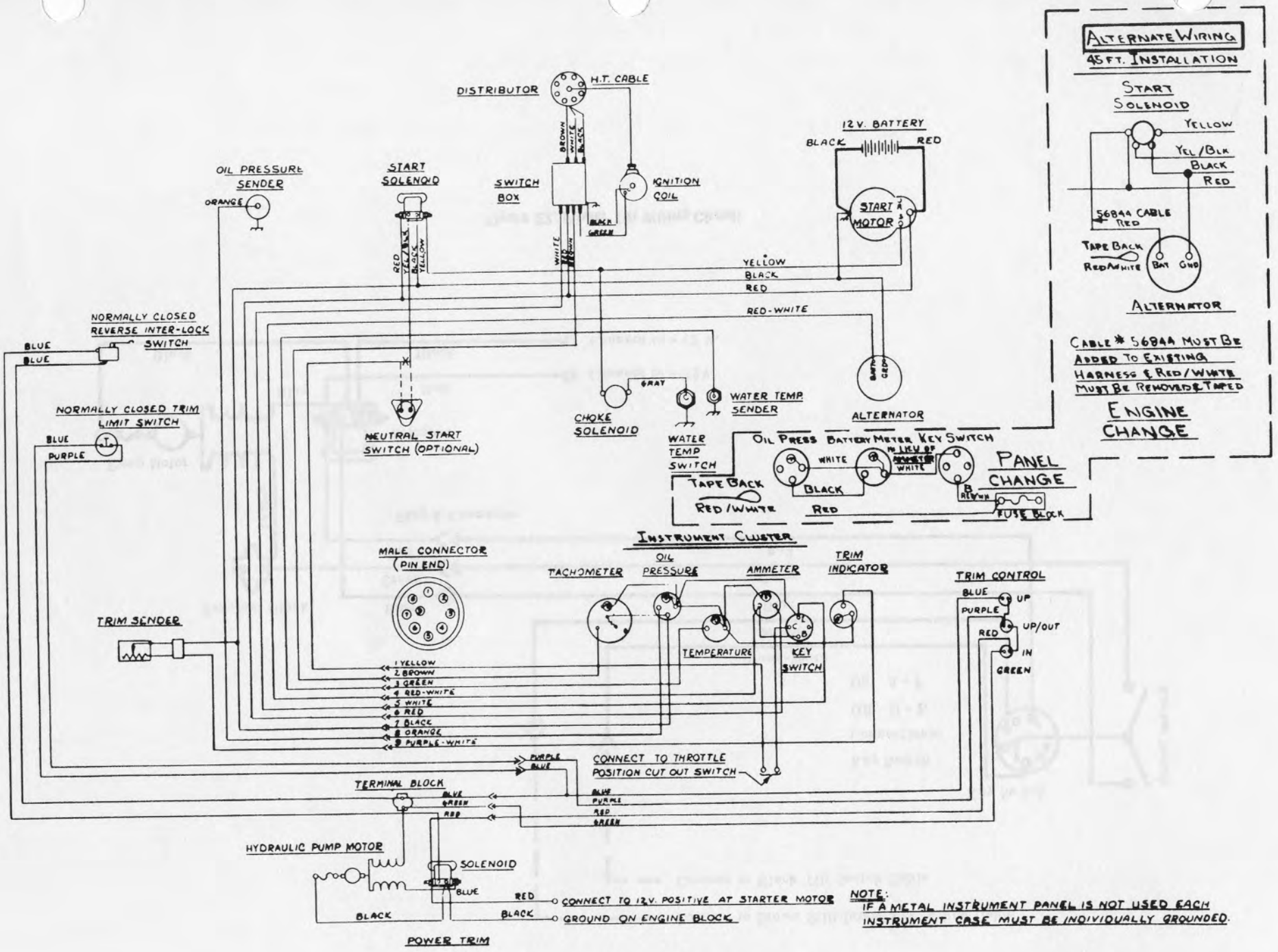


Figure 21. Engine Wiring Diagram - MerCruiser 270

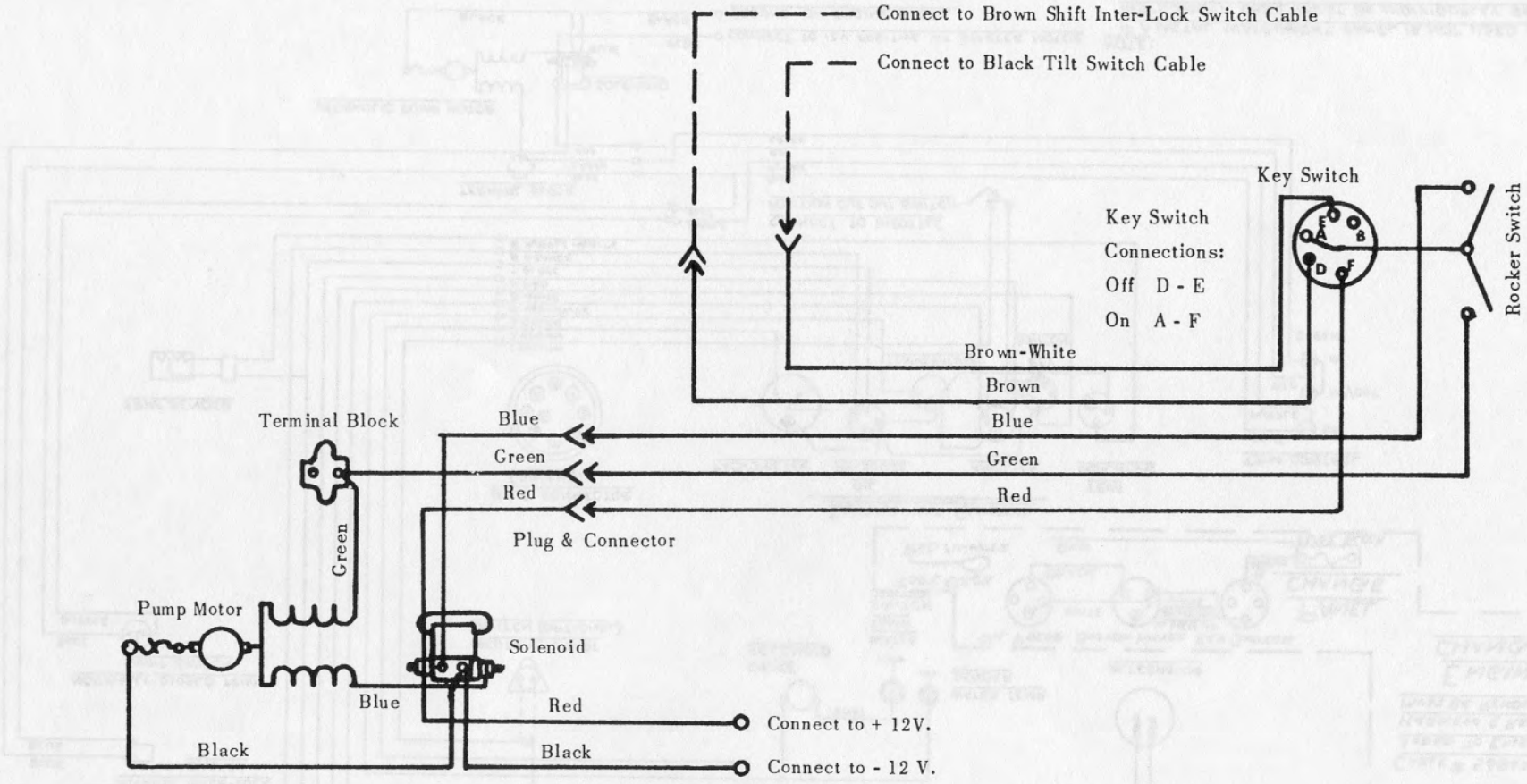


Figure 22. Power Tilt Wiring Circuit

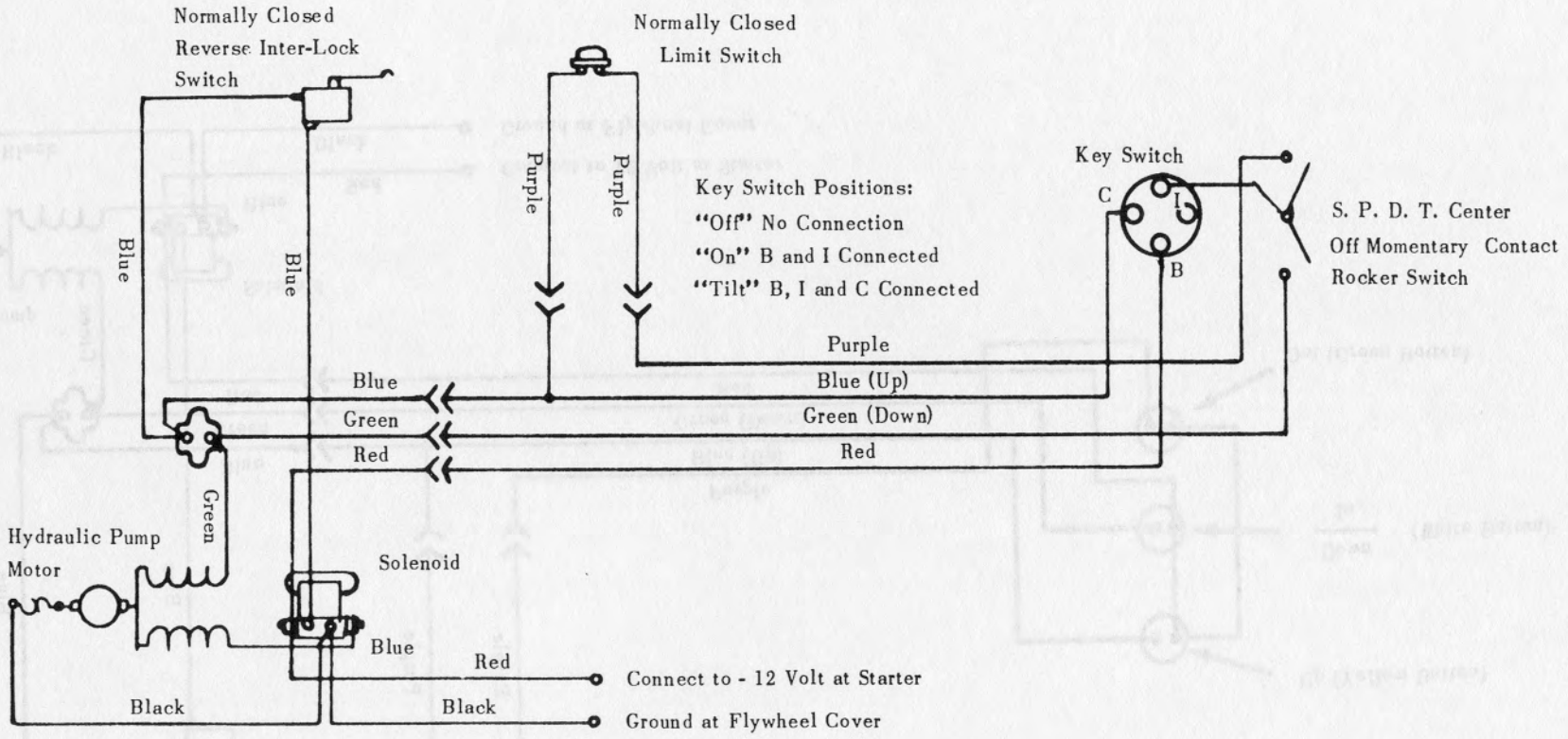


Figure 23. Power Trim Wiring Circuit with Rocker Switch

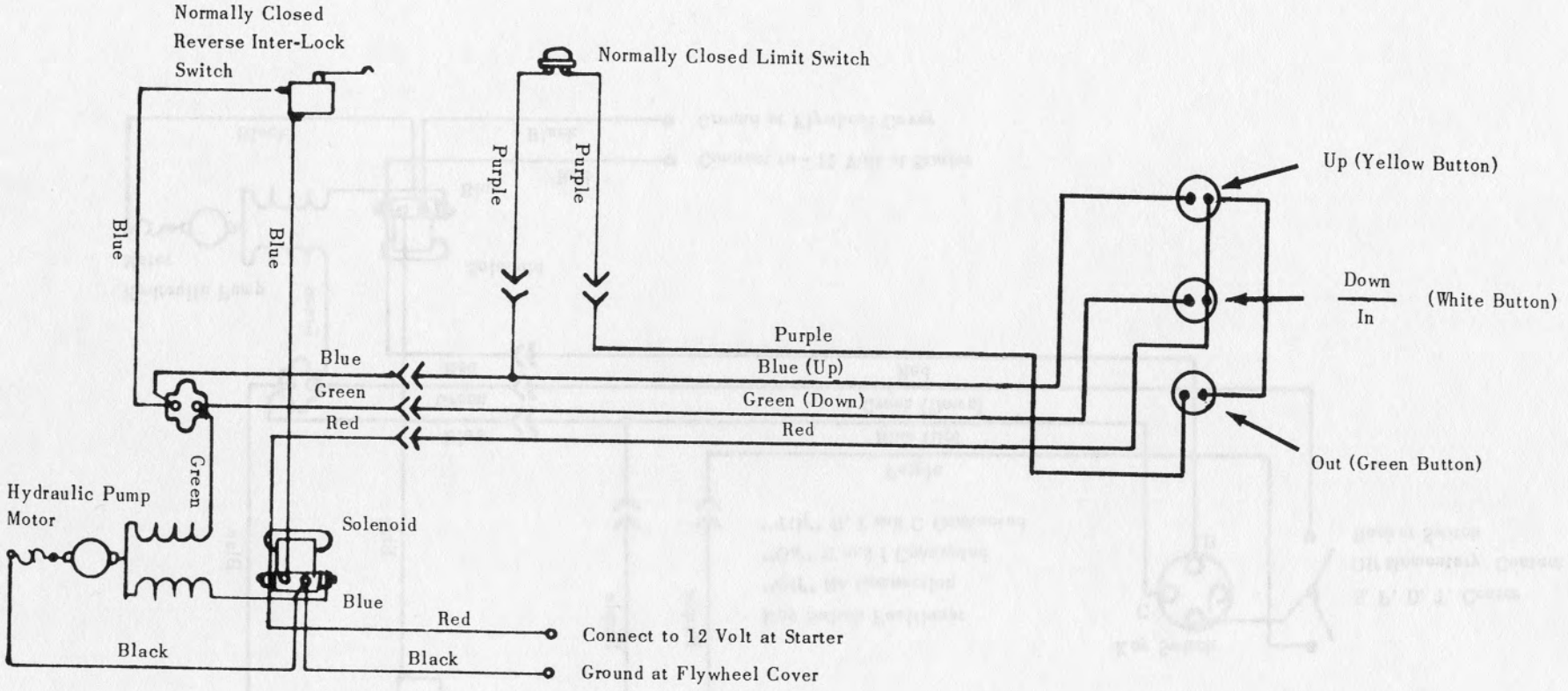


Figure 24. Power Trim Wiring Circuit with Early Push Button

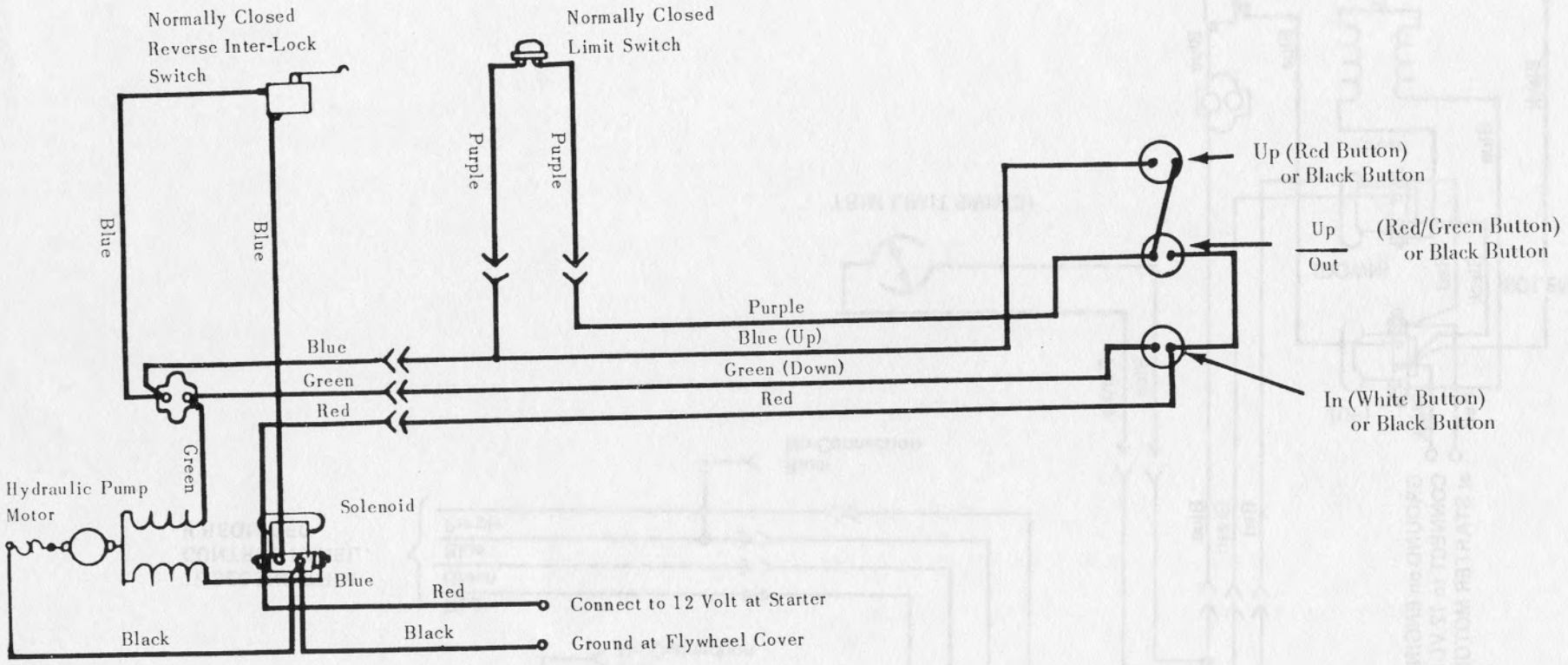


Figure 25. MerCruiser Power Trim Wiring Circuit with Late Push Button (One Solenoid)

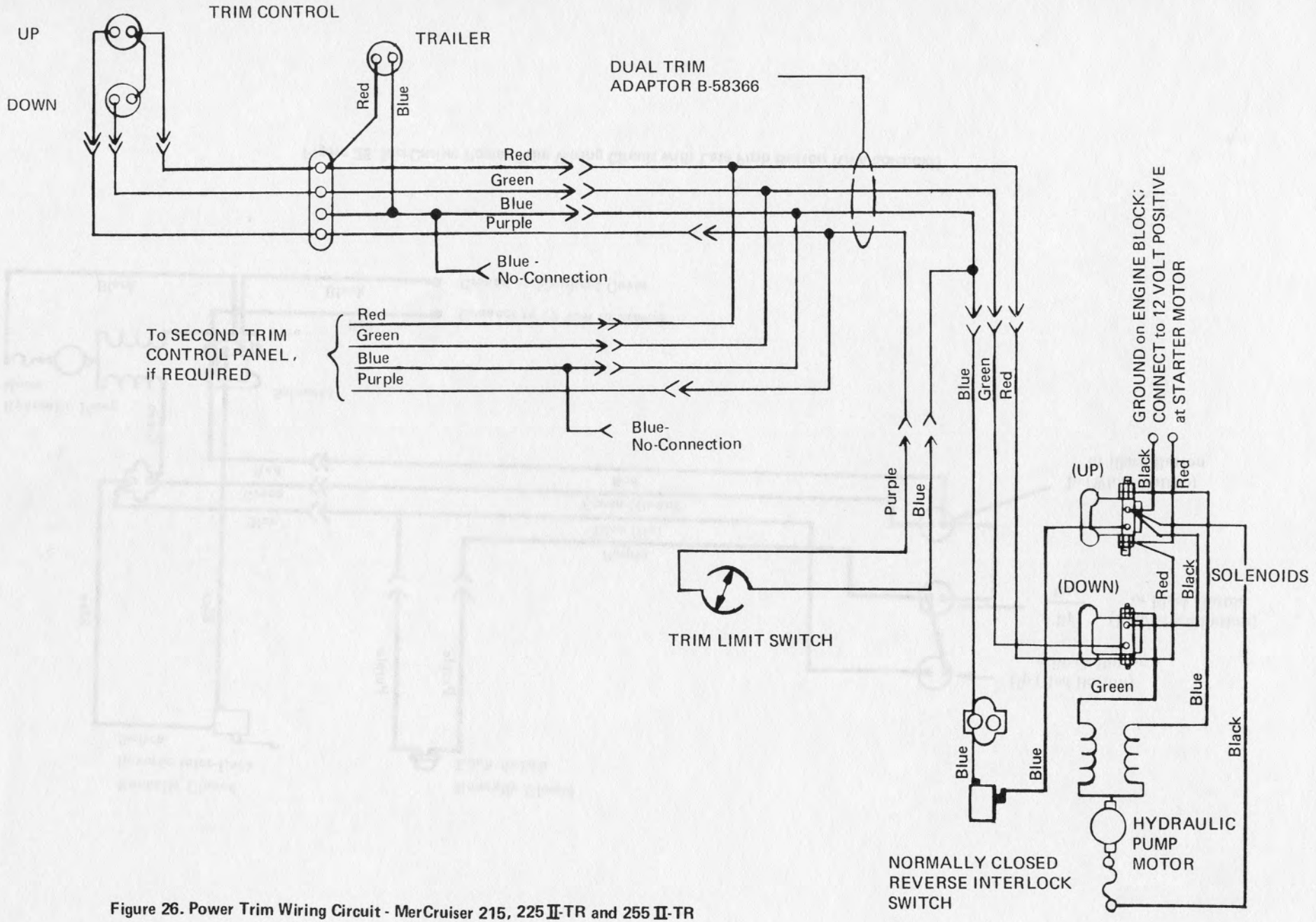
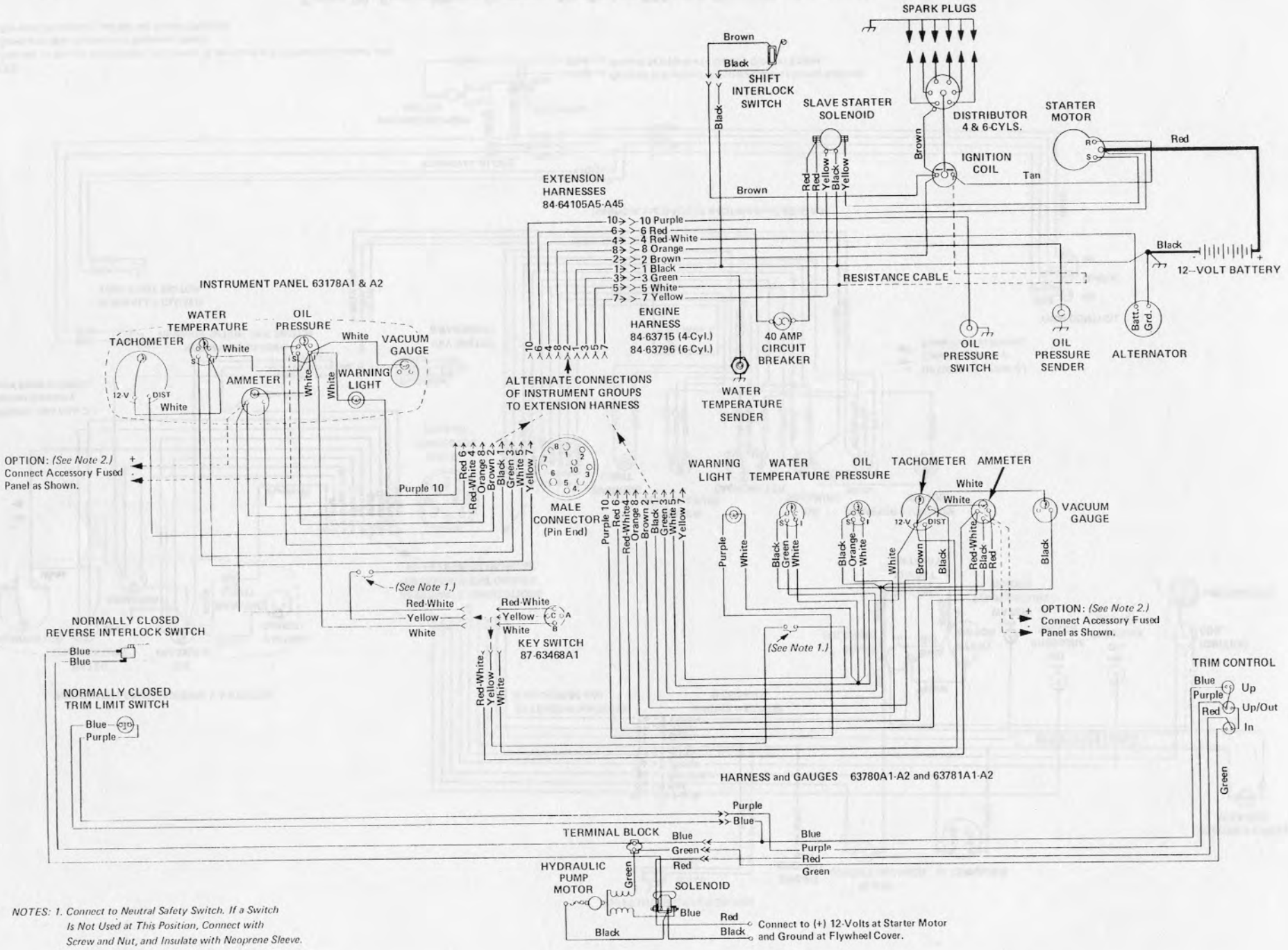
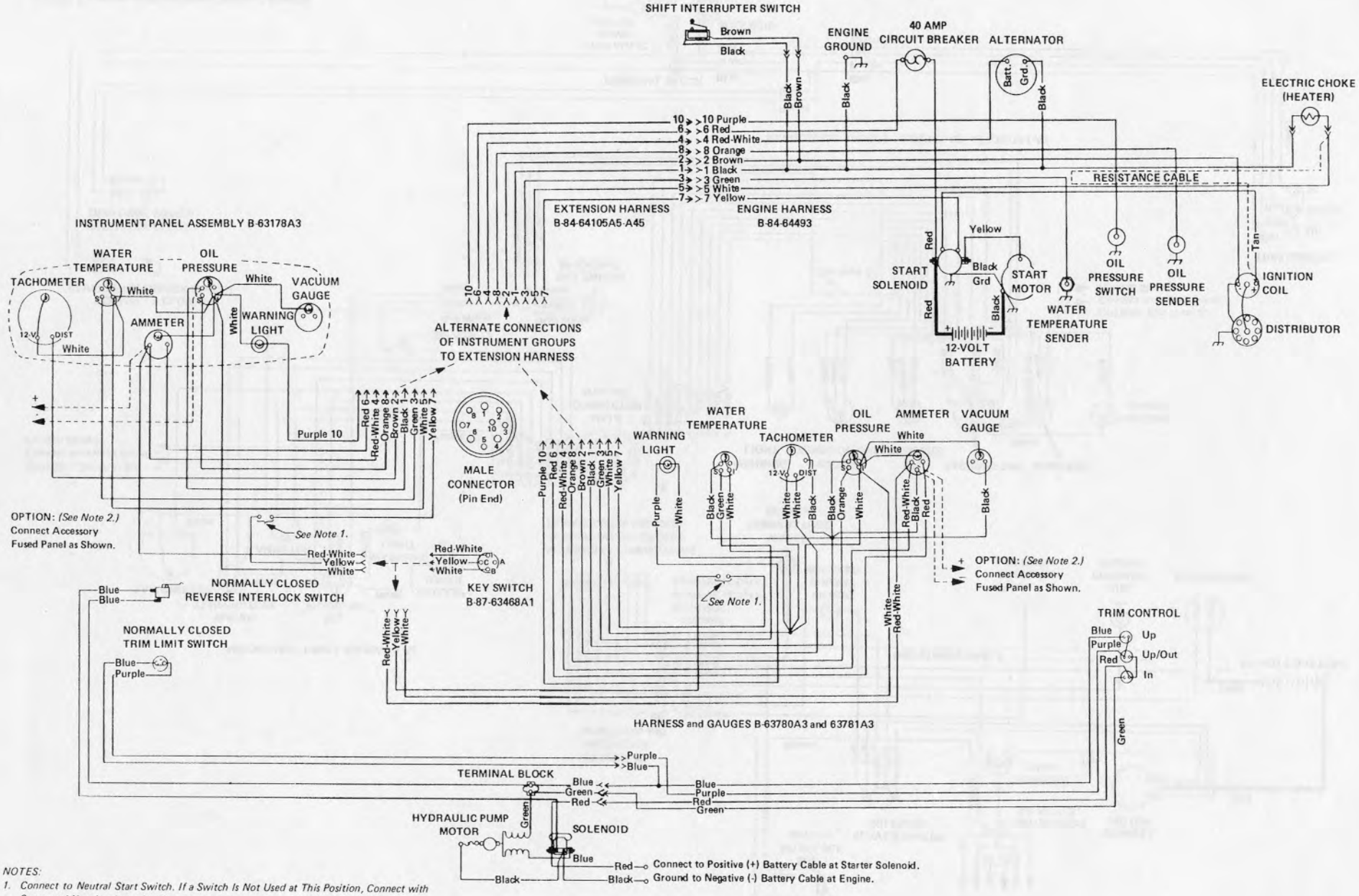


Figure 26. Power Trim Wiring Circuit - MerCruiser 215, 225 II-TR and 255 II-TR



NOTES: 1. Connect to Neutral Safety Switch. If a Switch Is Not Used at This Position, Connect with Screw and Nut, and Insulate with Neoprene Sleeve.
2. Electrical Accessory Load Cannot Exceed 35 Amps.

Figure 27. Engine Wiring Diagram - MerCruiser 120, 140 and 165 with Circuit Breaker and Vacuum Gauge



NOTES:

1. *Connect to Neutral Start Switch. If a Switch Is Not Used at This Position, Connect with Screw and Nut; Insulate with Neoprene Sleeve.*
2. *Electrical Accessory Load Cannot Exceed 35 Amps.*

Figure 28. Engine Wiring Diagram - MerCruiser 888 with Circuit Breaker and Vacuum Gauge

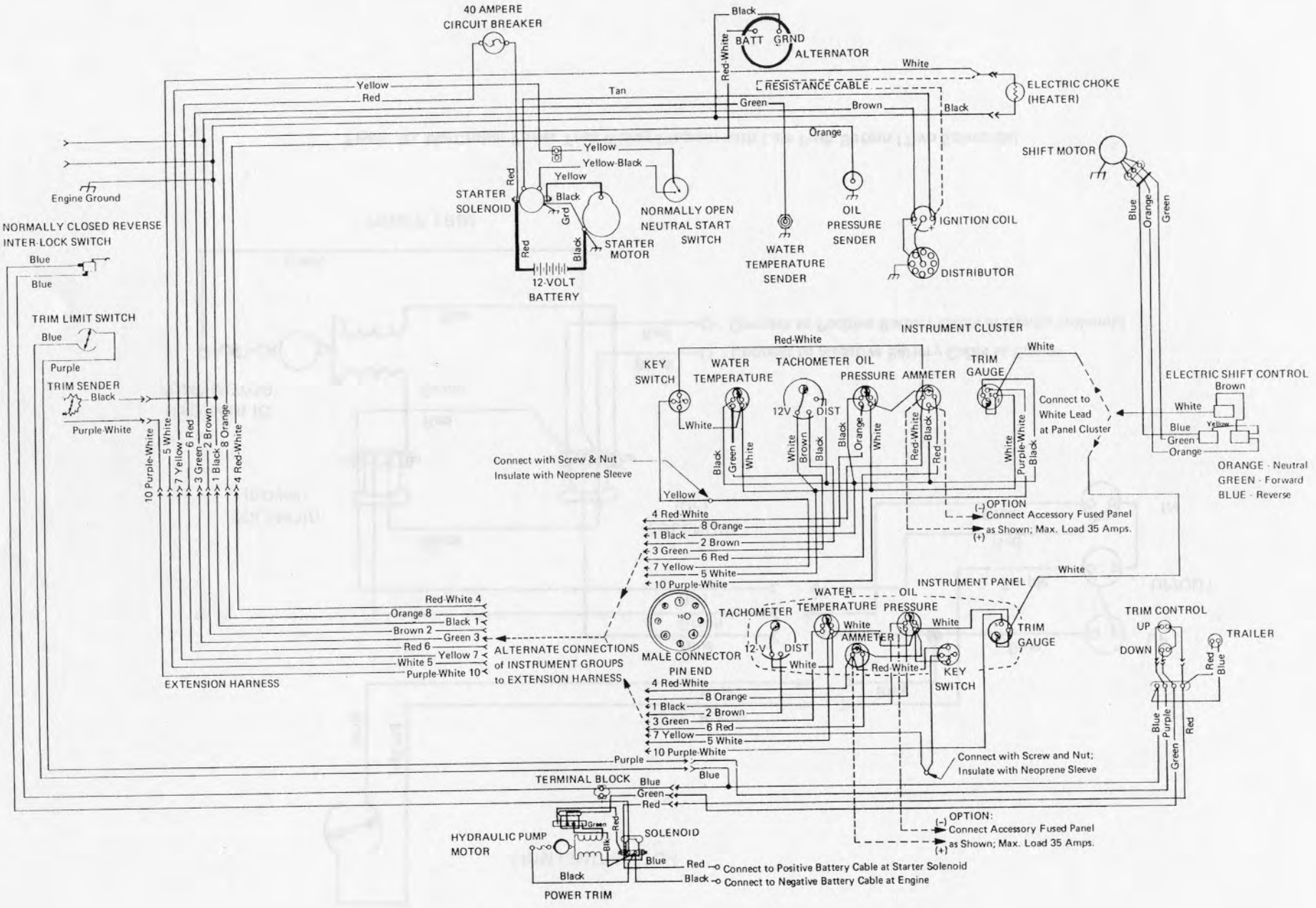


Figure 29. Engine Wiring Diagram - MerCruiser 225 II-TR and 255 II-TR

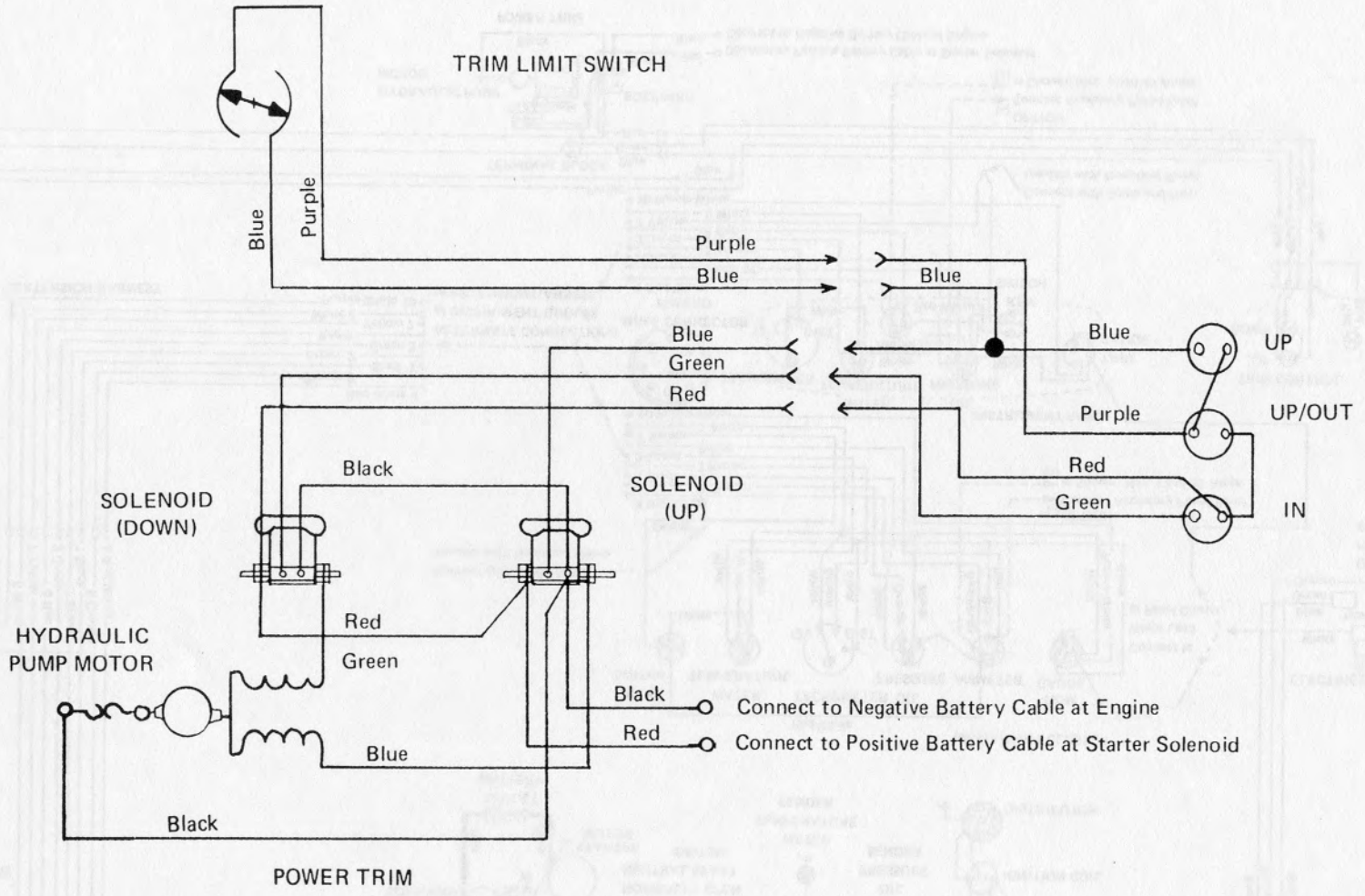
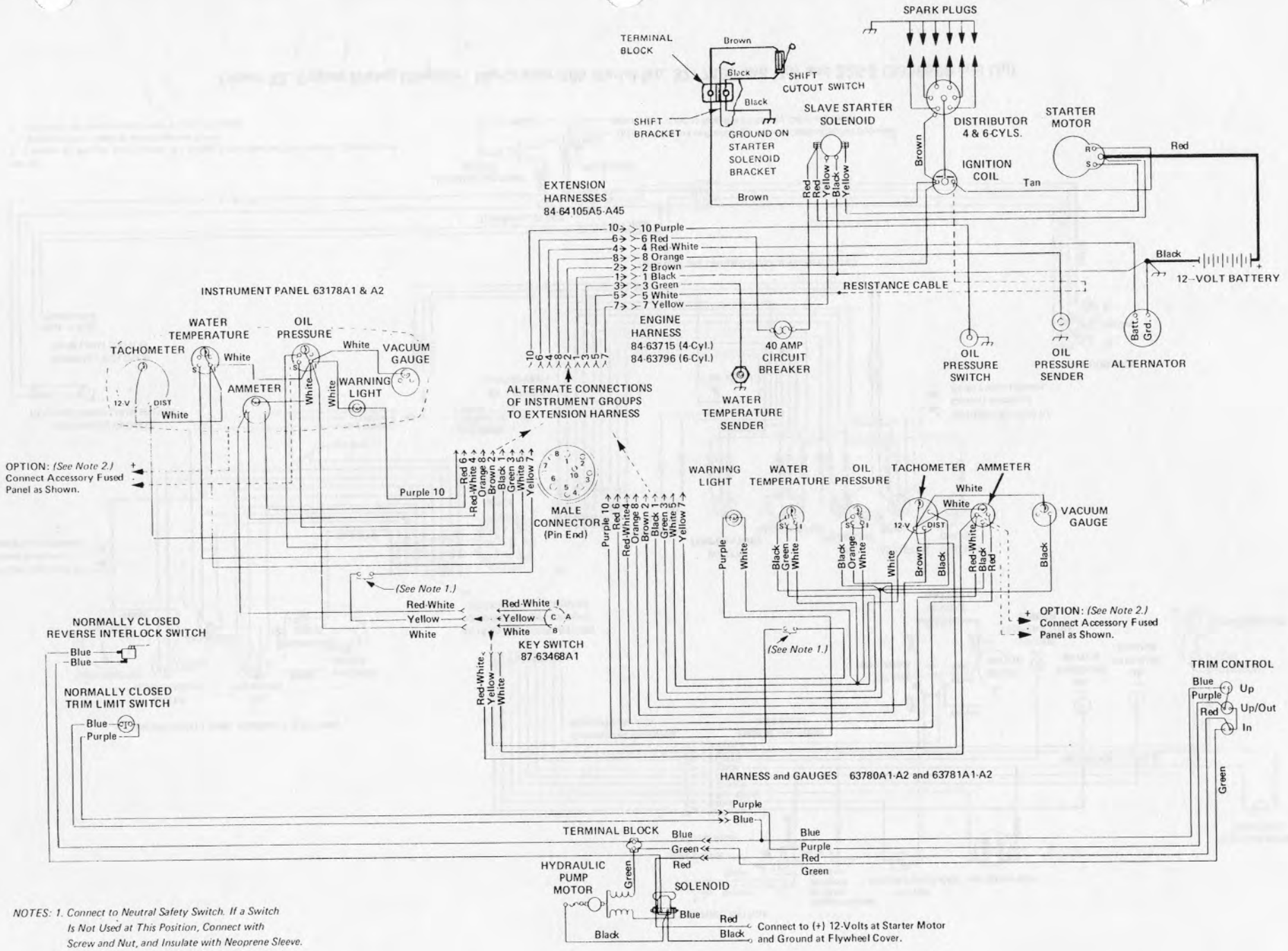


Figure 30. MerCruiser Power Trim Wiring Diagram with Late Push Button (Two Solenoids)



NOTES: 1. Connect to Neutral Safety Switch. If a Switch Is Not Used at This Position, Connect with Screw and Nut, and Insulate with Neoprene Sleeve.
2. Electrical Accessory Load Cannot Exceed 35 Amps.

Figure 31. Engine Wiring Diagram - MerCruiser 120 (Serial No. 3770650 and Up), 140 (3771645 and Up) and 165 (3774865 and Up)

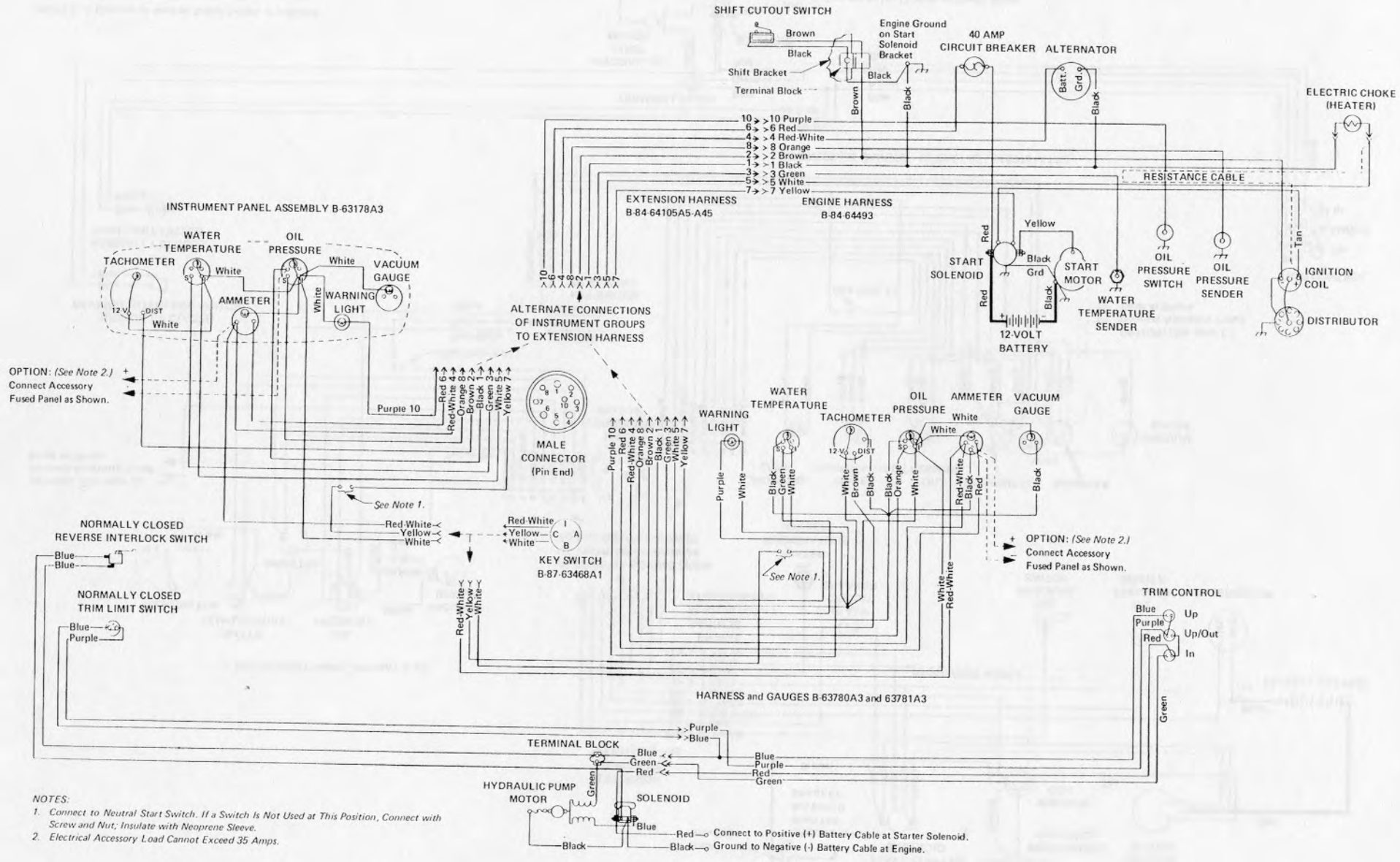


Figure 32. Engine Wiring Diagram - MerCruiser 888 (Serial No. 3777490 and Up) and 225-S (3836688 and Up)

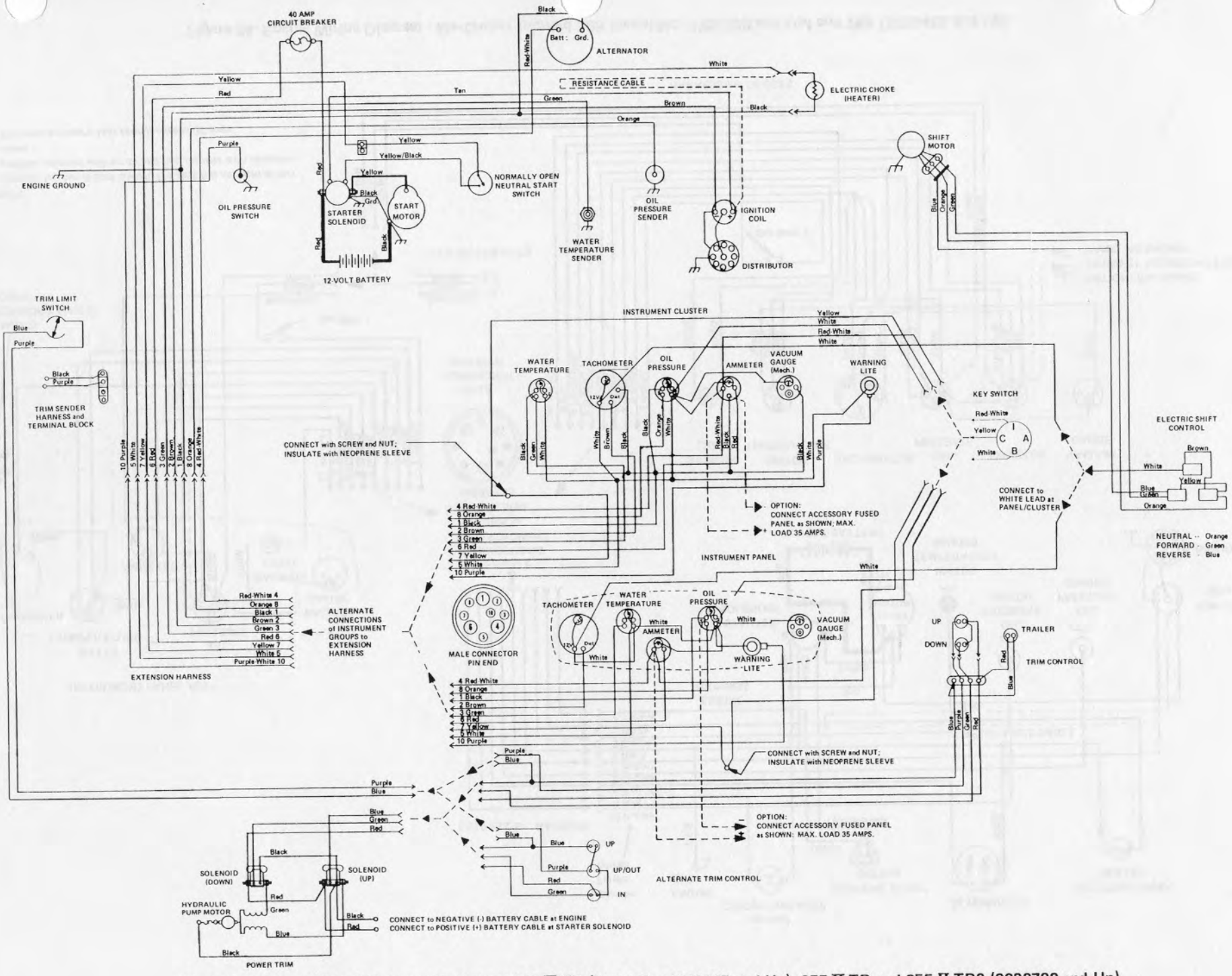
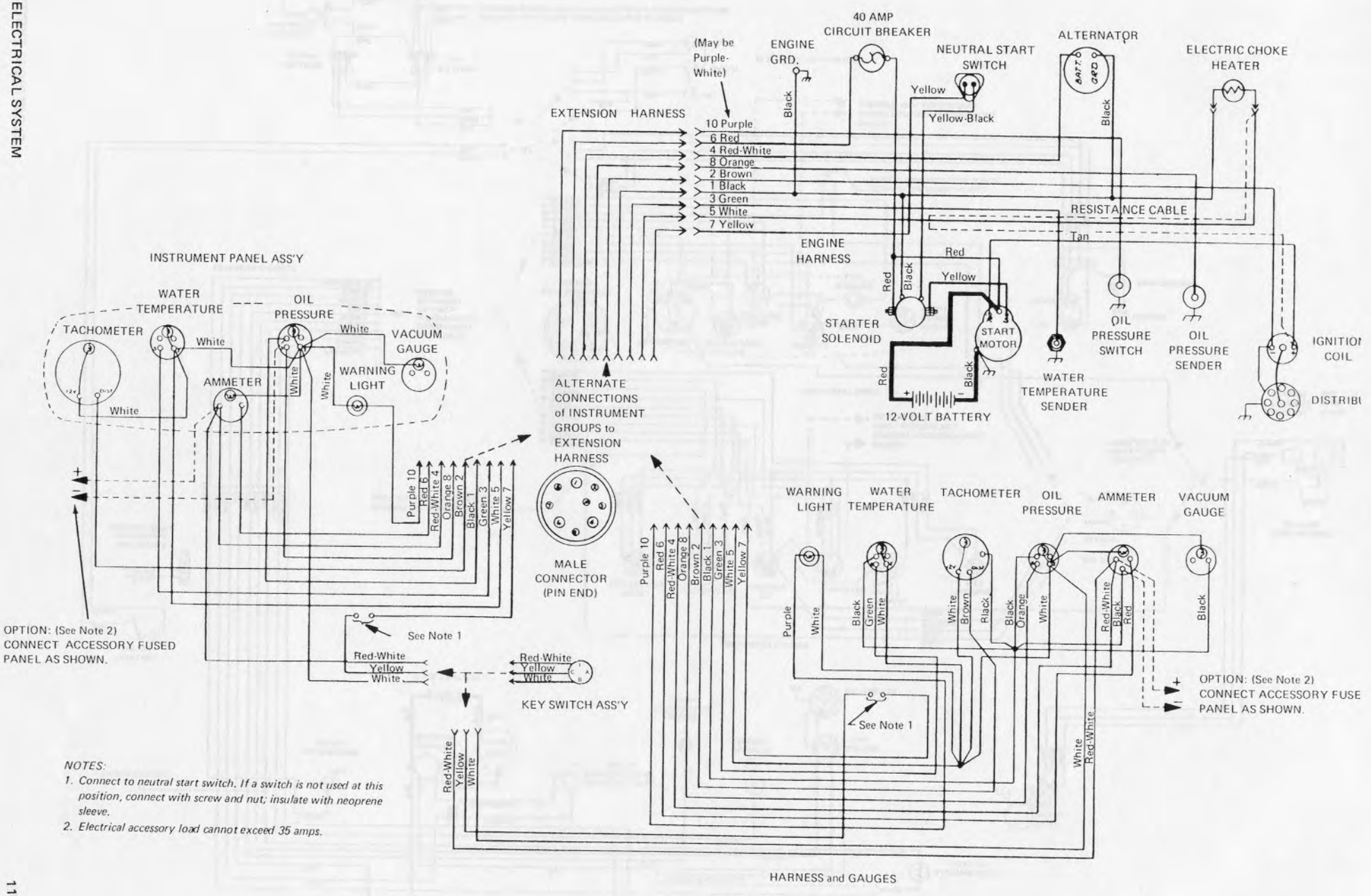


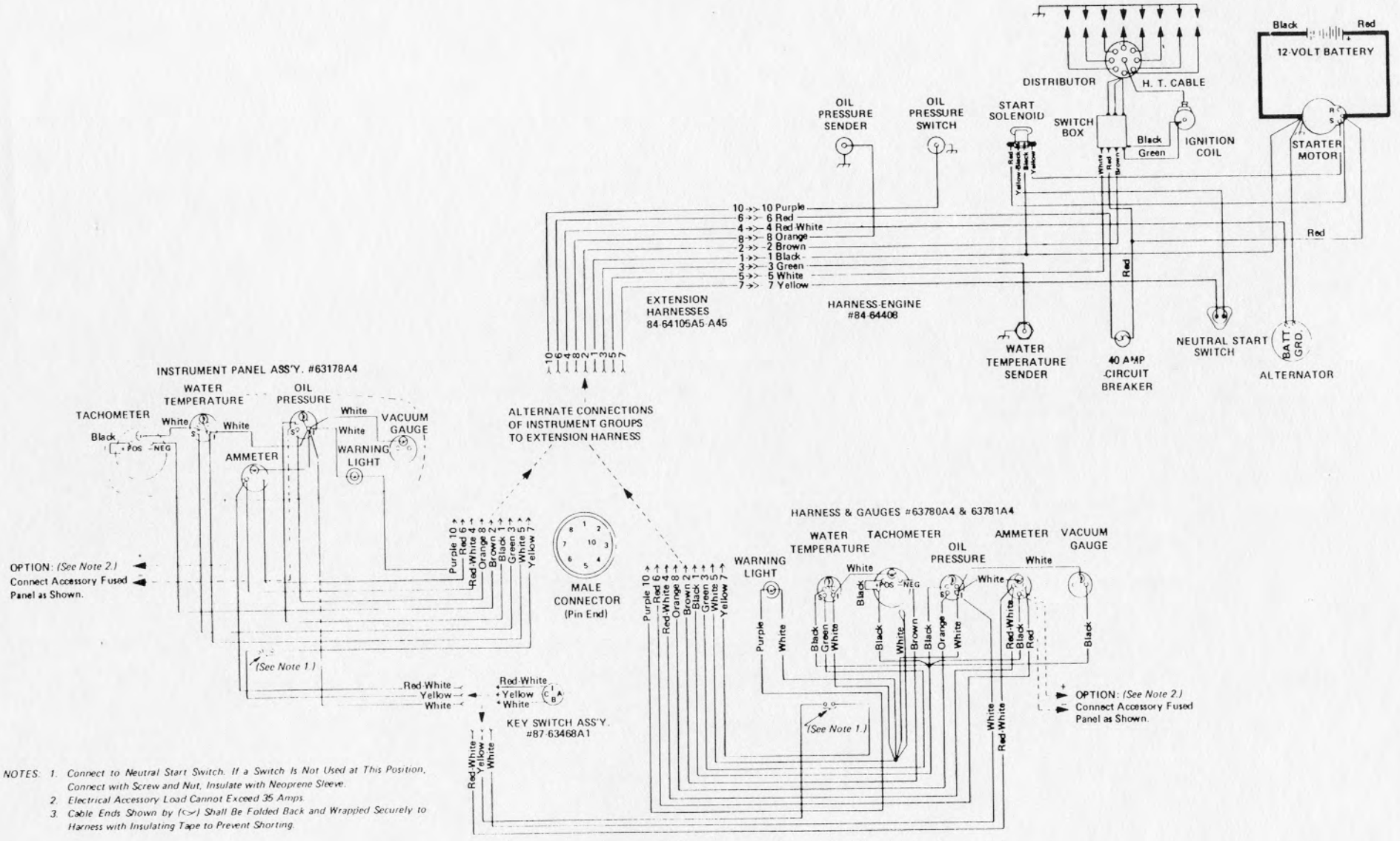
Figure 33. Engine Wiring Diagram - MerCruiser 225 II-TR (Serial No. 3779775 and Up), 255 II-TR and 255 II-TRS (3838788 and Up)



NOTES:

1. *Connect to neutral start switch. If a switch is not used at this position, connect with screw and nut; insulate with neoprene sleeve.*
2. *Electrical accessory load cannot exceed 35 amps.*

Figure 34. Engine Wiring Diagram - MerCruiser Inboard 225 (Serial No. 3750508 and Up) and 255 (3839488 and Up)

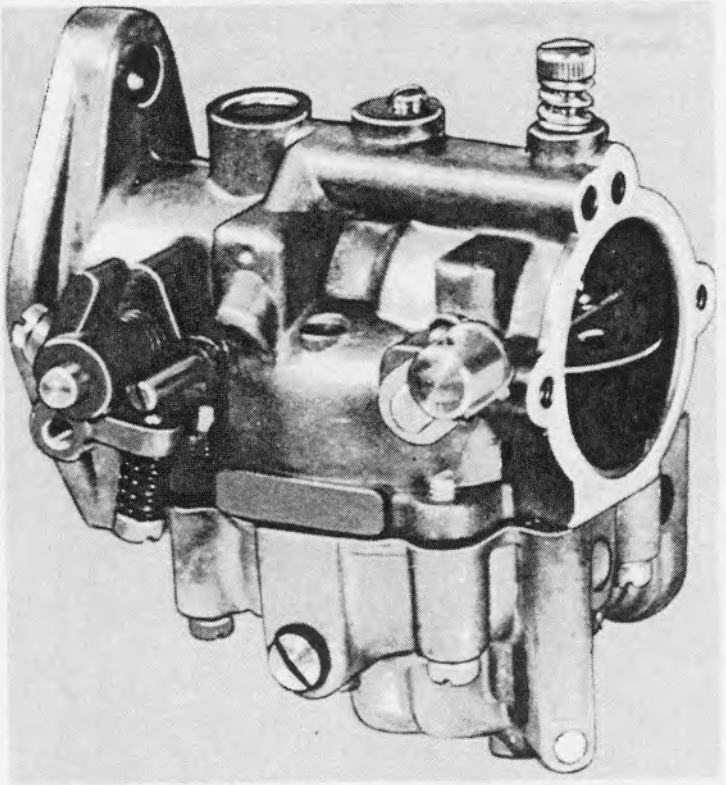


NOTES:
1. Connect to Neutral Start Switch. If a Switch Is Not Used at This Position, Connect with Screw and Nut, Insulate with Neoprene Sleeve.
2. Electrical Accessory Load Cannot Exceed 35 Amps.
3. Cable Ends Shown by (<) Shall Be Folded Back and Wrapped Securely to Harness with Insulating Tape to Prevent Shorting.

Figure 35. Engine Wiring Diagram - MerCruiser Inboard 350 (Serial No. 3780450 and Up)

MERCRUISER

SECTION 4



FUEL SYSTEM

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SECTION 4 - FUEL SYSTEMS

MERCRUISER

PART A - FUEL PUMPS

MERCURY MARINE

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FUEL SYSTEM

DESCRIPTION

This section is divided into "Fuel Pumps" and "Carburetors" and covers general fuel system performance specifications and adjustment procedures required within the fuel system. Removal, installation, cleaning and inspection of the carburetor and fuel pump are included.

COMPONENTS

Several different fuel pumps and carburetors, used for stern drive and inboard application, will be discussed separately in this section.

PRECAUTIONS

Before servicing the fuel system, always disconnect the negative (-) battery terminal. This will prevent accidental shorting which may ignite fuel that is spilled when fuel lines are disconnected.

INSTALLING FUEL LINE CHECK VALVE

110-120-150 Models

A check valve and fuel line can be installed on MerCruiser 110-120-150 engines to eliminate excessive cranking after fuel tank or carburetor runs dry. If engine does not have a fuel line check valve, install one as follows: (Figure 1)

1. Remove tee fitting from carburetor and install fitting on discharge side of fuel pump.
2. Remove present restrictor and install check valve (B-22-45122) into tee fitting on inlet side of fuel filter.
3. Connect hose (B-32-45121) between check valve and tee.
4. Reverse fuel line and install.
5. Remove clip and install clip B-54-28938.

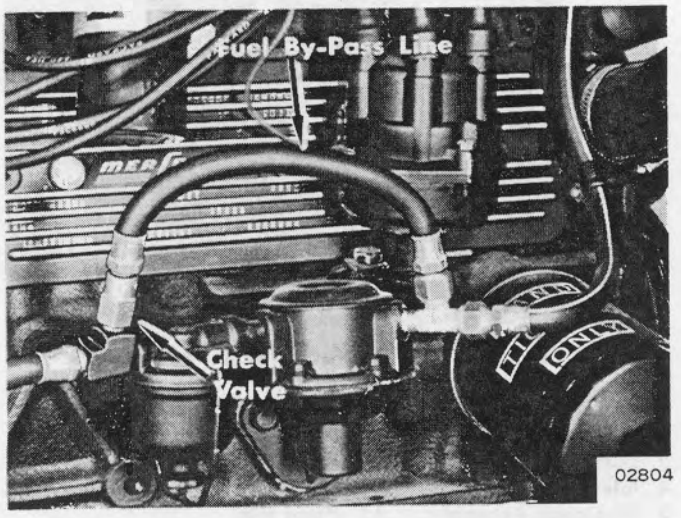


Figure 1. Fuel Line Check Valve - 110-120-150 Models

PART A - FUEL PUMPS

AC FUEL PUMP

DESCRIPTION

Fuel pumps, used on 4, 6 and 8-cylinder models, are diaphragm type. Pumps are operated by an eccentric (located toward front end of engine camshaft). On 4 and 6-cylinder models, an eccentric on camshaft actuates pump rocker arm. The 8-cylinder pump rocker arm is actuated by a push rod located in cylinder block between pump and fuel pump eccentric on camshaft. The 8-cylinder model pump is inverted (relative to the 6-cylinder model pump) and has a larger capacity. A rubber oil seal is used on both pumps. Figures 2 and 3 show a cross-section of each pump.

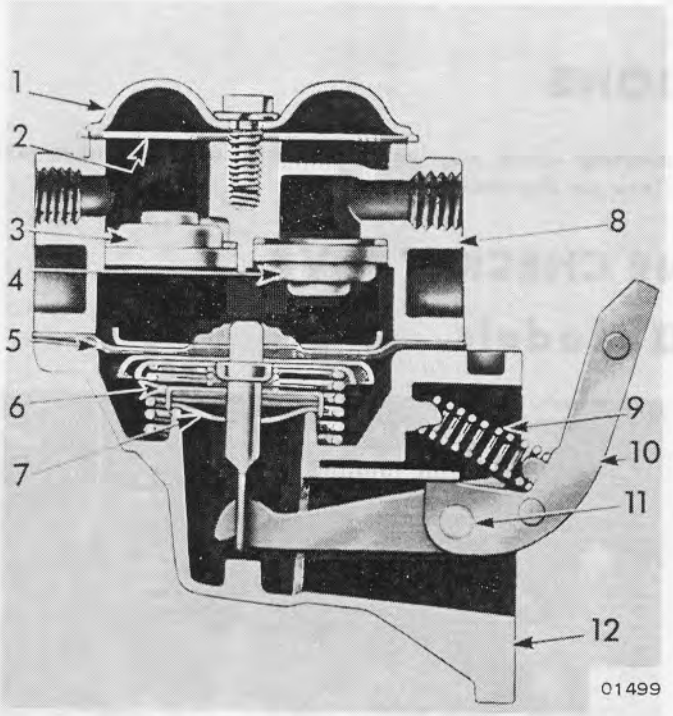


Figure 2. Four and 6-Cylinder Fuel Pump

1 Pulsator Cover
2 Pulsator Diaphragm
3 Outlet Valve
4 Inlet Valve
5 Diaphragm Assembly
6 Diaphragm Spring
7 Oil Seat
8 Fuel Cover
9 Rocker Arm Return Spring
10 Rocker Arm and Lever Assembly
11 Pivot Pin
12 Pump Body

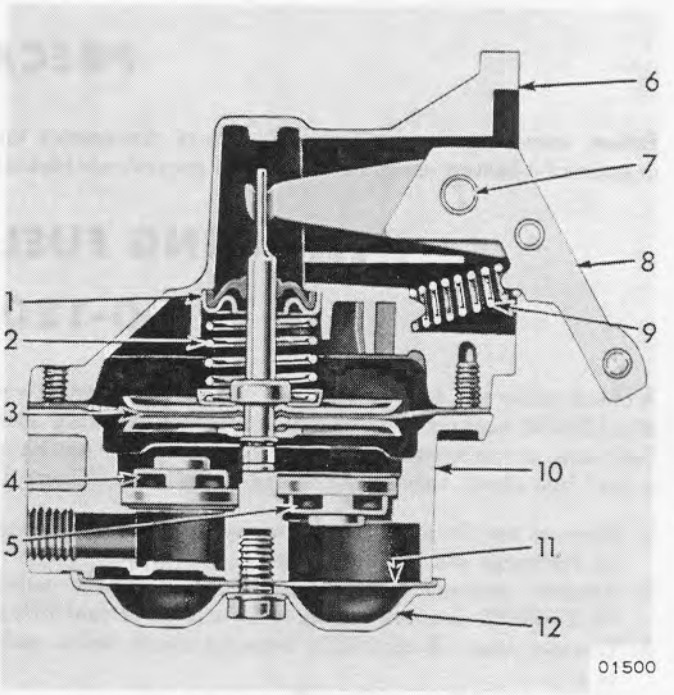


Figure 3. Eight-Cylinder Pump Cross-Section

1 Oil Seal and Retainer
2 Diaphragm Spring
3 Diaphram Assembly
4 Inlet Valve
5 Outlet Valve
6 Pump Body
7 Pivot Pin
8 Rocker Arm and Lever Assembly
9 Rocker Arm Return Spring
10 Fuel Cover
11 Pulsator Diaphragm
12 Pulsator Cover

PRECAUTIONS

Check regularly to be sure mounting bolts, cover-to-body bolts, pulsator diaphragm cover screws and inlet and outlet connections are tight.

TROUBLESHOOTING

Always check pump while mounted on engine and be sure that gasoline is present in fuel tank.

Line from tank to pump is suction side of system, and line from pump to carburetor is pressure side. A leak on pressure side, therefore, would be evident from dripping fuel, but a leak on suction side would not be apparent, except from reducing volume of fuel on pressure side. If poor high speed performance, fuel pump may be at fault. Too low a pump pressure or volume will cause a high speed "miss", because of lack of fuel delivered to carburetor, while too high a pressure will cause carburetor flooding.

PUMP VOLUME

1. Disconnect fuel line at carburetor and direct line into a container indicating pint level.
2. Start engine and run at idle, using fuel in carburetor bowl.
3. Measure time required to deliver one pint of fuel, then shut off engine. At idle, pump should deliver one pint of fuel in 30 to 45 seconds.
   a. If no gasoline or only a small amount flows from open end of line, fuel line is clogged or pump is inoperative. Before removing pump, remove fuel tank filler cap, disconnect both inlet and outlet lines from pump and blow thru lines with air hose to clear passage and eliminate possible clogged fuel filter in fuel tank. Reconnect lines to pump and retest flow.
   b. If pump volume is within limits, proceed with "Pump Pressure Test", following.

PUMP PRESSURE TEST

1. Disconnect fuel line at fuel filter and attach fuel pump pressure gauge to fuel line.
2. Start engine and run at idle. Observe reading on gauge.
3. If pump is operating properly, pressure will be 5¼ to 6½ PSI for V-8 engine, 3½ to 4½ PSI for 4 and 6-cylinder engines, 1¾ to 3½ PSI for "60", "80" and "90" engines, and will remain constant at speeds between idle and 1000 RPM. If pressure is too low or too high, or varies at different speeds, remove pump for repair. If fuel pump pressure checks out correctly after a high speed problem, overhaul carburetor.
4. Remove gauge and reconnect fuel line to filter. Inspect fuel line for kinks and sharp bends and check all connections for leaks.

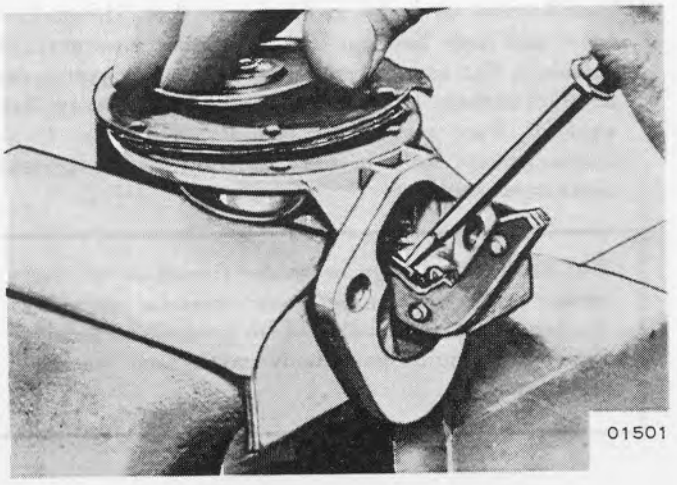
REMOVAL

1. Disconnect fuel inlet and outlet lines at fuel pump and fuel cover.
2. Remove 2 fuel pump mounting bolts and lockwashers, pump and gasket.
3. On 8-cylinder models, if removing rocker arm push rod, detach 2 adaptor mounting bolts and lockwashers and remove adaptor and gasket from lock. Remove push rod from block.

NOTE: After removal of pump from engine and before disassembly is started, plug all openings and thoroughly wash exterior of pump with cleaning solvent to remove all dirt and grease.

DISASSEMBLY

NOTE: Various AC fuel pumps have basically identical disassemblies.



1. Remove fuel pulsator diaphragm plate and diaphragm from fuel cover.
2. Mark edges of fuel cover and body flange with file. Parts then may be reassembled in same relative position.
3. Remove cover screws and lockwashers. Separate fuel cover from body by jarring cover loose with a light plastic hammer.
4. Raise fuel pump link with a screwdriver. (Figure 4) Unhook diaphragm from link by pressing down and away from rocker arm side. Remove oil seal and retainer from diaphragm.

NOTE: Figure 5 depicts the 4 and 6-cylinder pump as a typical disassembly.

Figure 4. Raising Fuel Link

1 Rocker Arm
2 Rocker Arm Return Spring
3 Actuating Lever
4 Pump Body
5 Diaphragm Spring
6 Lower Seal Retainer
7 Oil Seal
8 Upper Seal Retainer
9 Seal Spring
10 Diaphragm Spring Upper Seat
11 Diaphragm
12 Fuel Cover and Valves
13 Pulsator Diaphragm
14 Pulsator Cover
15 Rocker Arm Pin

Figure 5. Four and 6-Cylinder Pump Disassembled 01502

CLEANING and INSPECTION

1. Clean and rinse all metal parts in solvent. Blow out all passages with air hose.
2. Inspect pump body and fuel cover for cracks, breakage and distorted flanges. Examine all screw holes for stripped or crossed threads. Pump assembly replacement is advisable if one of main castings is not serviceable.
3. Inspect rocker arm and link for excessive wear and for loose hinge pin.
4. Use proper diaphragm repair kit to replace diaphragm.
5. Replace rocker arm spring and diaphragm springs as removed. Old springs may be distorted, weak or corroded.
6. Check condition of valves by pushing each valve off its seat with a thin rod or pencil. Insert hooked wire thru inlet opening in fuel cover to move fuel inlet valve off its seat. If a valve sticks to its seat, if it moves off its seat and does not rebound or, if cage is damaged, complete valve must be replaced. To remove valves, clear staked metal (with a sharp chisel, file or suitable scraper) and pull valve out with a hook-shaped tool.

REASSEMBLY

1. Install oil seal to diaphragm push rod in following manner: Assemble oil seal spring, upper retainer, 2 leather seals and lower retainer with convex side out. This is extremely important in order to seal fuel pump from any oil that might rise from crankcase. Raise fuel pump link with a screwdriver (Figure 4), install diaphragm spring and hook diaphragm pull rod over end of link.
2. If either valve was removed from fuel cover, install by placing gasket in recess and pressing valve into place. Outlet valve cage must face bottom of cover, and inlet valve cage must face opposite. Secure valve assembly by staking cover metal in 4 places around valve.
3. Place new pulsator diaphragm over fuel cover opening, install plate and retain with screw and fiber washer.
4. Install cover on body, making sure that file marks on cover and body line up. Push on rocker arm until diaphragm is flat across body flange. Install cover screws and lockwashers loosely until screws just engage lockwashers. Push rocker arm thru its full stroke to flex diaphragm and hold in that position while tightening cover screws securely.

CAUTION: Diaphragm must be flexed to its full stroke while tightening cover screws, or pump diaphragm protector will not be properly centered, thereby rubbing on pump body casting and wearing diaphragm.

INSTALLATION

1. Install fuel pump gasket and fuel pump.
2. Connect fuel lines to pump.
3. Start engine and check for leaks.

CARTER FUEL PUMP (Part No. B-47585)

DESCRIPTION

The Carter fuel pump is similar to the AC fuel pump, preceding. The differences only will be discussed in this section.

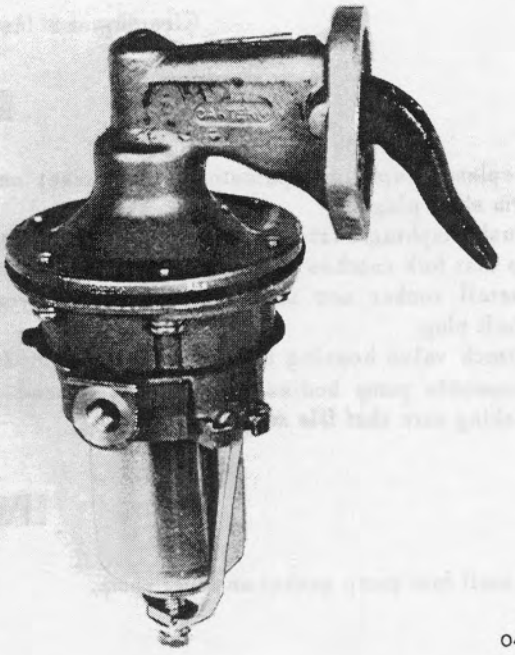


Figure 1. Carter Fuel Pump

04923

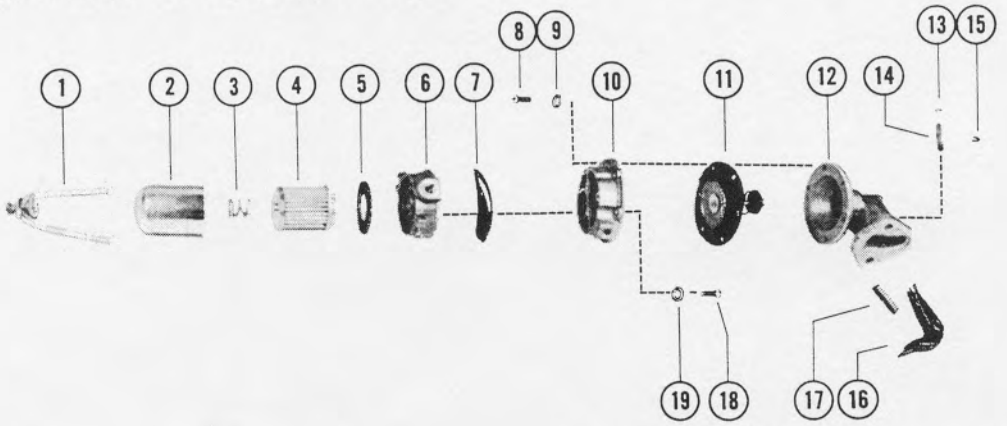
PRECAUTIONS, TROUBLESHOOTING and REMOVAL

Precautions, Troubleshooting and Removal are the same as the AC fuel pump, preceding.

DISASSEMBLY

1. Mark edges of fuel cover and body flange with file. Parts then may be reassembled in same relative position.
2. Loosen screw and remove filter holder, filter and gasket.
3. Remove 6 phillips head screws and pump body.

Figure 2. Carter Fuel Pump Exploded View



04900

1 Filter Cover Retainer
2 Filter Cover
3 Filter Spring
4 Filter
5 Filter Gasket
6 Pulsator Housing
7 Pulsator
8 Screw
9 Lockwasher
10 Valve Body
11 Diaphragm
12 Pump Body
13 Rocker Arm Pin Plug
14 Rocker Arm Pin
15 Rocker Arm Retainer
16 Rocker Arm
17 Rocker Arm Spring
18 Screw
19 Lockwasher

4. Remove 2 screws and lockwasher and separate lower housing, pulsator diaphragm and valve housing.
5. Remove spring, rocker arm shaft plug, safety pin, rocker arm shaft and rocker arm from main body.
6. Remove diaphragm seal assembly.

CLEANING and INSPECTION

Cleaning and Inspection are same as AC fuel pump, preceding.

REASSEMBLY

1. Replace diaphragm, pulsator, filter gasket and rocker arm shaft plug.
2. Push diaphragm into pump body and install rocker arm so that fork catches diaphragm.
3. Install rocker arm shaft, safety pin and rocker arm shaft plug.
4. Attach valve housing to lower housing with 2 screws.
5. Assemble pump bodies with 6 phillips head screws, making sure that file marks line up.

CAUTION: Diaphragm must be flexed to its full stroke while tightening cover screws, or pump diaphragm protector will not be properly centered, thereby rubbing on pump body casting and wearing diaphragm.

6. Reassemble filter to pump body, replacing filter.

INSTALLATION

1. Install fuel pump gasket and fuel pump.
2. Connect fuel lines to pump.
3. Start engine and check for leaks.

MERCRUISER "60" FUEL PUMP (Part No. B-37135)

DESCRIPTION

MerCruiser 60 fuel pump is similar to the AC fuel pump, preceding. The differences only will be discussed in this section.

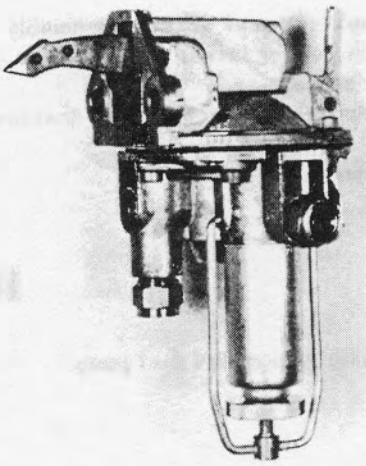


Figure 1. MerCruiser "60" Fuel Pump

04921

PRECAUTIONS, TROUBLESHOOTING and REMOVAL

Precautions, Troubleshooting and Removal are same as AC fuel pump, preceding.

DISASSEMBLY

1. Mark edges of fuel cover and body flange with file. Then reassemble parts in same relative position.
2. Loosen thumb nut and remove filter case and filter from pump body.
3. Remove 6 screws and separate pump body.
4. Remove nut and lockwasher from top of diaphragm.
5. Remove 4 pieces of diaphragm, diaphragm spring, spring and retainer.
6. Remove spring from rocker arm.
7. Remove oil seal and rod from rocker arm.

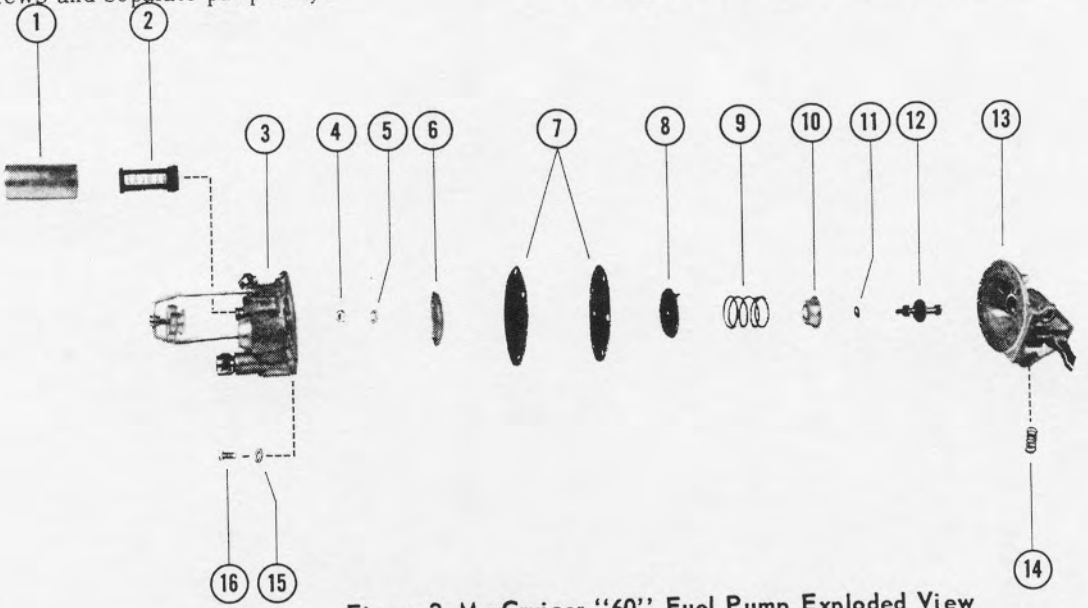


Figure 2. MerCruiser "60" Fuel Pump Exploded View

04902

1 Filter Cover
2 Filter
3 Valve Housing
4 Nut
5 Washer
6 Diaphragm Retainer
7 Diaphragm
8 Spring Retainer
9 Seal Spring
10 Spring Seat
11 Gasket
12 Diaphragm Bolt
13 Pump Body
14 Spring Rocker Arm Return
15 Washer
16 Bolt

CLEANING and INSPECTION

Cleaning and Inspection are same as AC fuel pump, preceding.

REASSEMBLY

1. Assemble diaphragm and oil seal assembly and insert in pump housing under rocker arm.
2. Install rocker arm spring.
3. Assemble body halves together with 6 screws, making sure that file marks line up.
4. Insert new filter in filter holder.

CAUTION: Diaphragm must be flexed to its full stroke while tightening cover screws, or pump diaphragm protector will not be properly centered, thereby rubbing on pump body casting and wearing diaphragm.

INSTALLATION

1. Install fuel pump gasket and fuel pump.
2. Connect fuel lines to pump.
3. Start engine and check for leaks.

MERCRUISER "80" FUEL PUMP (Part No. B-46666A1)

DESCRIPTION

MerCruiser "80" fuel pump is similar to AC fuel pump, preceding. The differences only will be discussed in this section.

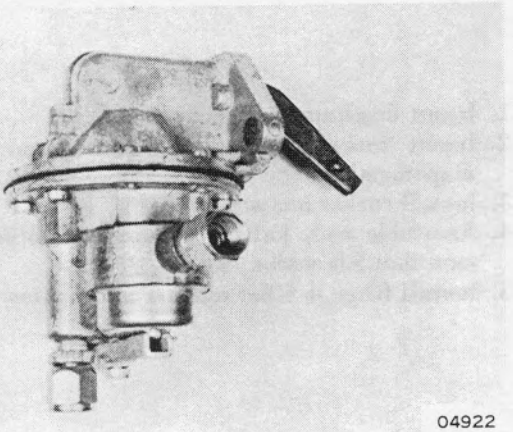


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Figure 1. MerCruiser "80" Fuel Pump

PRECAUTIONS, TROUBLESHOOTING and REMOVAL

Precautions, Troubleshooting and Removal are same as AC fuel pump, preceding.

DISASSEMBLY

1. Mark edges of fuel cover and body flange with file. Parts then may be assembled in same relative position.
2. Remove screw filter retainer and filter.
3. Remove 8 screws and separate body halves.
4. Remove rocker arm screw and pull out rocker arm assembly.
5. Remove diaphragm.

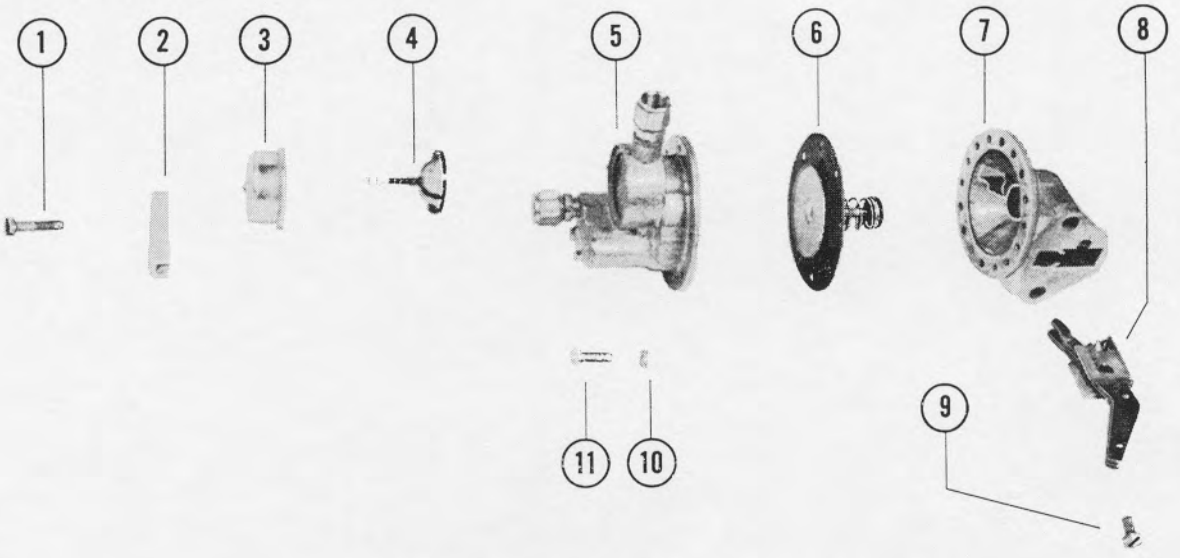

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Figure 2. MerCruiser "80" Fuel Pump Exploded View

1 Bolt
2 Filter Cover Retainer
3 Filter Cover
4 Filter
5 Valve Housing
6 Diaphragm
7 Pump Body
8 Rocker Arm Assembly
9 Rocker Arm Assembly Screw
10 Lockwasher
11 Bolt

CLEANING and INSPECTION

Cleaning and Inspection are same as AC fuel pump, preceding.

REASSEMBLY

1. Insert diaphragm into pump body.
2. Insert rocker arm assembly into pump body to hold diaphragm.
3. Install rocker arm screw.
4. Assemble body halves together with 8 screws, making sure that file marks line up.
5. Install filter in filter retainer and tighten screw.

CAUTION: Diaphragm must be flexed to its full stroke while tightening cover screws, or pump diaphragm protector will not be properly centered, thereby rubbing on pump body casting and wearing diaphragm.

INSTALLATION

1. Install fuel pump gasket and fuel pump.
2. Connect fuel lines to pump.
3. Start engine and check for leaks.

MERCRUISER "90" FUEL PUMP

DESCRIPTION

MerCruiser "90" fuel pump is actuated by a push rod which rides on a cam lobe. Pump is similar to AC fuel pump, preceding.

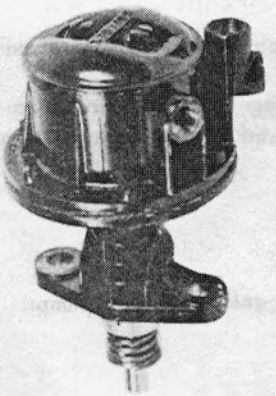

Figure 1. MerCruiser "90" Fuel Pump

06119

PRECAUTIONS, TROUBLESHOOTING and REMOVAL

Precautions, Troubleshooting and Removal are same as AC fuel pump, preceding.

DISASSEMBLY (Figure 2)

1. Remove 2 screws, cover, gasket and filter.
2. Remove 6 screws and valve body.
3. Press down on diaphragm and remove spring retainer from push rod.
4. Remove spring and diaphragm assembly.
5. Remove pin and disassemble push rod from diaphragm.

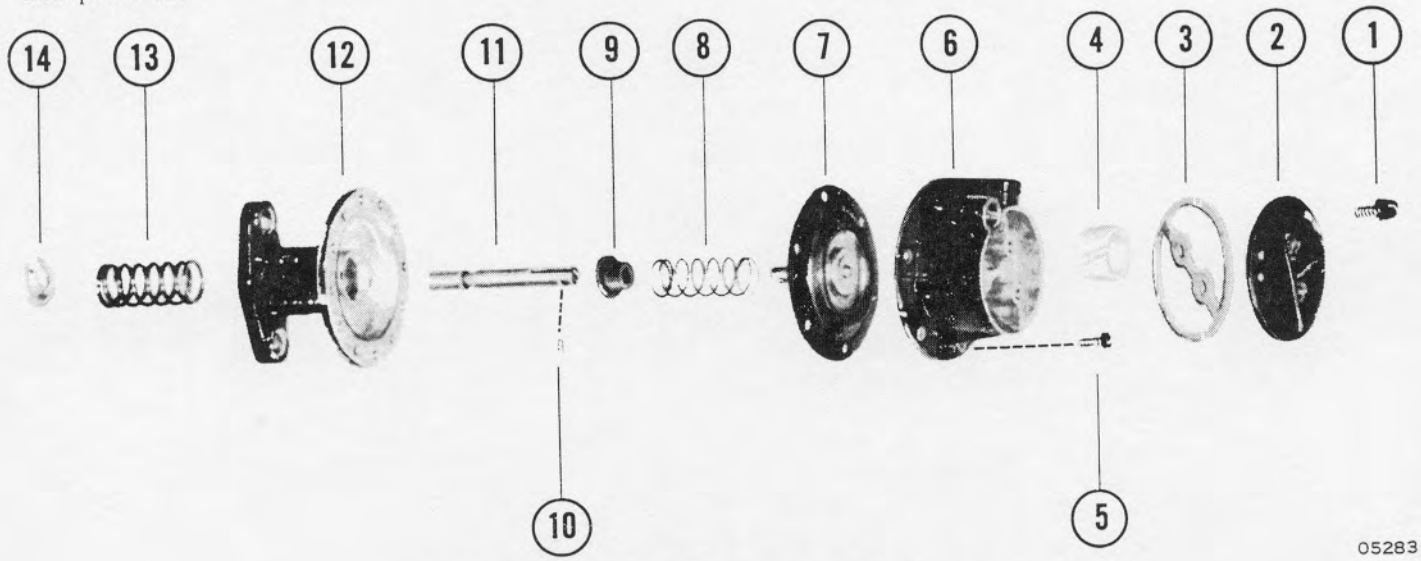

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Figure 2. MerCruiser "90" Fuel Pump Exploded View

1 - Screw
2 - Cover
3 - Gasket
4 - Filter
5 - Screw
6 - Valve Housing
7 - Diaphragm
8 - Spring
9 - Oil Seal
10 - Pin
11 - Pump Body
12 - Pump Housing
13 - Spring
14 - Spring Retainer

CLEANING and INSPECTION

Cleaning and Inspection are same as AC fuel pump, preceding.

REASSEMBLY

1. Assemble diaphragm, spring, seal and push rod together with pin.
2. Insert diaphragm assembly into pump body.
3. Insert spring and spring retainer to push rod.
4. Assemble valve body to pump body with 6 screws.
5. Insert filter and cover gasket and attach cover with 2 screws.

INSTALLATION

1. Install pump gasket and fuel pump.
2. Connect fuel lines to pump.
3. Start engine and check for leaks.

DUAL DIAPHRAGM FUEL PUMP

DESCRIPTION

These pumps have 2 diaphragms (separated by a metal spacer) and a sight gauge attached.

Dual diaphragm construction has 3 important safety features.

1. If main diaphragm fails, pump continues to function with second diaphragm.
2. No gasoline can leak outward from pump. It can leak only into space between diaphragms.
3. Gasoline in sight gauge exposes defective pump.

Possibility of diaphragms failing simultaneously is remote, since they are composed of different materials and are shaped differently.

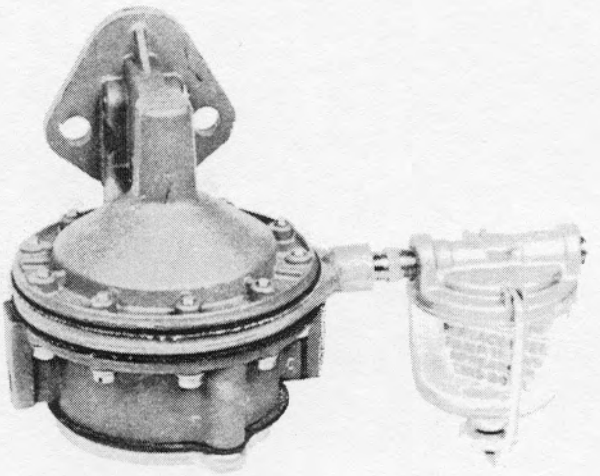

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Figure 1. Dual Diaphragm Fuel Pump

INSPECTION and REPLACEMENT

Dual diaphragm pump is not repairable and, therefore, must be replaced if defective. Inspect sight glass for fuel. If fuel is present, replace fuel pump.

Various carburetors, used with MerCruiser engines, are designed to meet particular requirements of engine and stern drive. Carburetors are carefully tested and adjusted before leaving the factory.

SECTION 4 - FUEL SYSTEMS

MERCRUISER

PART B - CARBURETORS

MERCURY MARINE

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PART B - CARBURETORS

MODEL "B" and "BC"

DESCRIPTION

Various carburetors, used with MerCruiser engines, are designed to meet particular requirements of engine and stern drive. Carburetors are carefully tested and adjusted before leaving the factory.

Model "B" carburetor is a single bore, downdraft type that is equipped with a manually-operated choke.

Model "BC" is the same as "B", except that "BC" has a fully automatic choke mounted on the air horn.

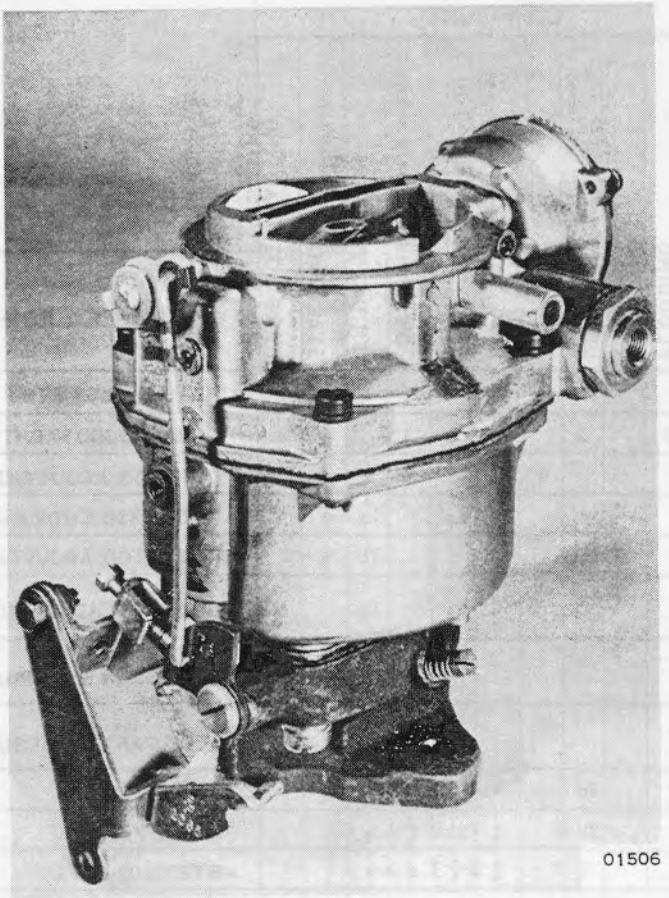

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Figure 1. Model "B" and "BC" Carburetors

PRECAUTIONS

Before making carburetor adjustments, make sure that carburetor-to-manifold and manifold-to-cylinder head bolts are tight, thus preventing air leaks.

Engine must be warmed-up to operating temperature (at least 15 minutes running time), or carburetor misalignment will occur. All carburetor adjustments may be made without removing carburetor from engine.

TROUBLESHOOTING

Use following troubleshooting chart to isolate a problem.

NOTE: Refer to Section 8 for current specifications.

CARBURETORS
TROUBLE SHOOTING CHART

* Numbers under each complaint heading indicate order of probability of causes listed. ★ Indicates other possible troubles.

(Always Check "Trouble Chart" before Proceeding with Repairs to Be Sure That Difficulty Is Not Minor nor Does Not Lie Elsewhere.)

COMPLAINT										CHECK POINTS*	WHAT TO LOOK FOR
FLOODING	ROUGH IDLE	ECONOMY	HESITATION	ACCELERATION FLATNESS	SURGE	LOW TOP SPEED OR POWER	COLD OPERATION	STALLING	HARD HOT STARTING		
	1	★		★			★	1	★	IDLE ADJUSTMENT	Correct speed and mixture
2		3		★	3	3		3	★	FLOAT ADJUSTMENT	Use correct gauge
			1	★			★			PUMP ROD ADJUSTMENT	Use correct dimension, throttle valves closed
		★					1a	★	1	AUTOMATIC CHOKE ADJ.	Set to latest specification
							1b	★		CHOKE ROD ADJUSTMENT	Use correct gauge
							1c		2	UNLOADER ADJUSTMENT	Use correct gauge, throttle valves wide open; check to see that throttle linkage allows wide open position
							1d	★		SECONDARY LOCKOUT ADJ.	Proper clearance so cam is free to move with throttle valves closed
							1e	★		SECONDARY CONTOUR ADJ.	Proper clearance so throttle valves are free to move with choke open
		2a		1	4a	1	★			POWER PISTON	Dirty, distorted, sticking, incorrect part
		2b		2	4b	2	★			POWER VALVE	Dirty, sticking, incorrect part
		4		3	1	4	★			METERING JETS	Loose, plugged, incorrect part
1	★	★						2	3	NEEDLE & SEAT	Worn, damaged, dirty, incorrect part
	★	★	5	4	2	★				VENTURI CLUSTER	Dirty, loose screws, incorrect part
3		★			★			★	★	FLOAT	Bent, leaky
	3							★		IDLE NEEDLES	Worn, damaged
	4		★	★		★	★	★		THROTTLE VALVES	Sticking, open or closed, damaged
4	★	★	★	★	★	★	★	★	★	GASKETS	Improper seal, hard or brittle material, loose screws
	2							★	★	IDLE PASSAGES	Dirty
	★	★				★	★			POWER PISTON VACUUM PAS.	Plugged or vacuum leaks
	★	★					3		★	CHOKE VACUUM PASSAGE	Plugged or vacuum leaks
	★	★		★			★			THROTTLE BODY HEAT PAS.	Plugged with carbon
	★	★								PUMP BODY	Crack or loose fit on plunge shaft
			3				★			PUMP PLUNGER	Hard or worn leather, distorted spring, stuck vent ball check
★										FUEL FILTER	Clogged or dirty filter
			4				★			PUMP INLET CHECK	Out-of-round, damaged seat, stuck
	★		★				★	★	★	PUMP DISCHARGE CHECK	Out-of-round, damaged seat, stuck, distorted spring
		★		★			2	★	★	CHOKE PISTON	Dirty, damaged, sticking
		1					4		4	OPERATOR	Operating habits, correct procedures
			2							PUMP DISCHARGE JETS	Dirt, must be open

MAIN METERING STANDARD JET SIZES

Do not identify main metering jets by the orifice size which is stamped on front of jet. It is possible to have 3 different jets with the same size orifice, as jets are avialable with 3 different approach angles. Figures, shown below, illustrate the approach angles that a jet may have. All 3 could have the same size orifice, although each one will allow a different amount of fuel to flow thru the carburetor. When ordering replacement jets, order by part number and not by orifice size.

90° Approach Angle

Partial 60° Approach Angle

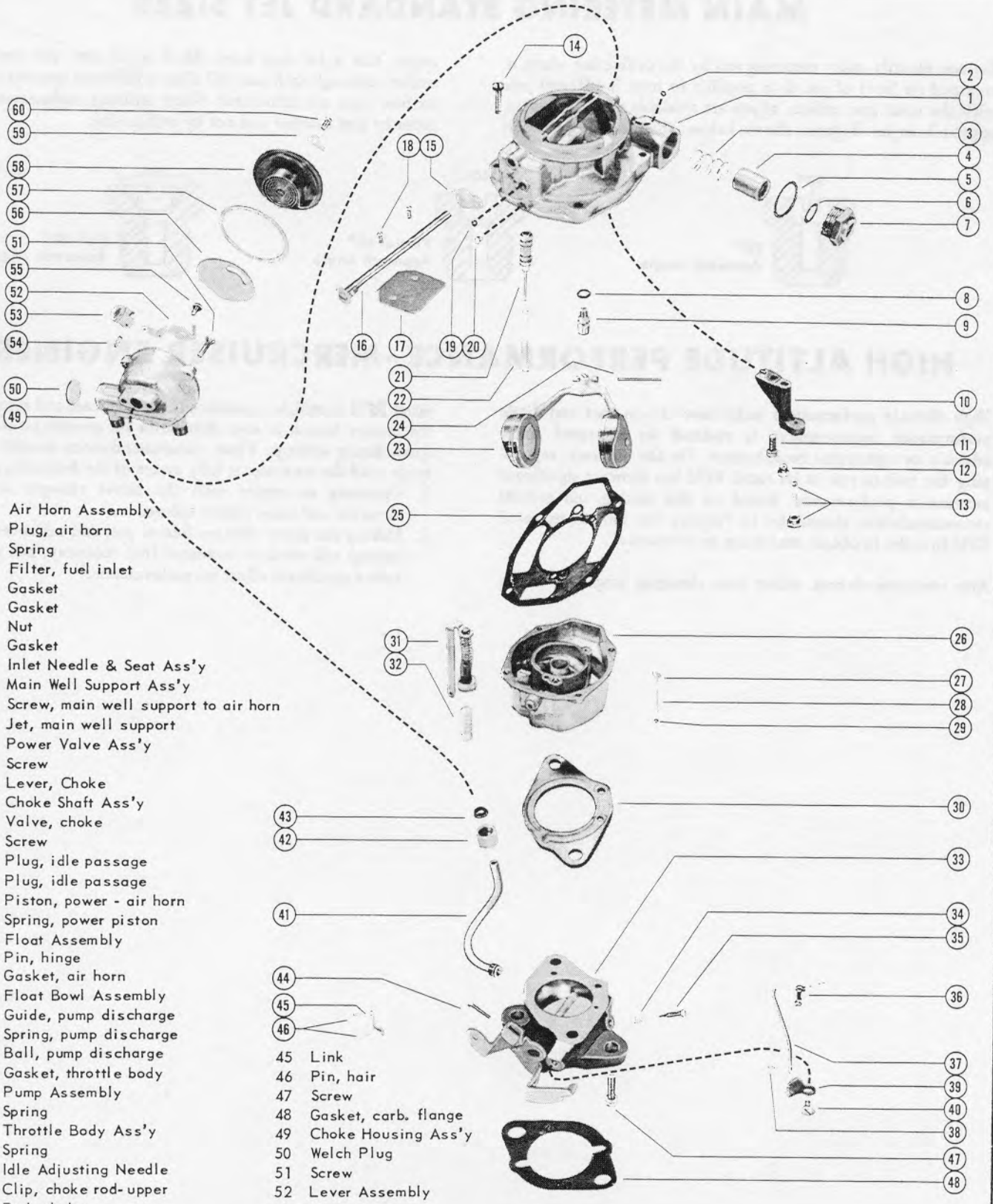
Full 60° Approach Angle

HIGH ALTITUDE PERFORMANCE -MERCRUISER ENGINES

High altitude performance tests have shown that very little performance improvement is realized by increased spark advance or carburetor recalibration. On the contrary, repropping the unit to run at its rated RPM has shown a significant increase in performance. Based on this testing, our general recommendation should be to "reprop the unit to its rated RPM in order to obtain maximum performance".

Any recommendation, other than changing props, to obtain rated RPM should be considered a special case and referred to the factory branch or area distributor for specific jet sizes and spark timing settings. These recommendations should not be made until the customer is fully aware of the following points:

1. Operating an engine with the above changes at lower elevation will cause engine failure.
2. Making the above changes (leaner jets and advanced spark timing) will result in increased fuel economy, but will not have a significant effect on performance.



1 Air Horn Assembly
2 Plug, air horn
3 Spring
4 Filter, fuel inlet
5 Gasket
6 Gasket
7 Nut
8 Gasket
9 Inlet Needle & Seat Ass'y
10 Main Well Support Ass'y
11 Screw, main well support to air horn
12 Jet, main well support
13 Power Valve Ass'y
14 Screw
15 Lever, Choke
16 Choke Shaft Ass'y
17 Valve, choke
18 Screw
19 Plug, idle passage
20 Plug, idle passage
21 Piston, power - air horn
22 Spring, power piston
23 Float Assembly
24 Pin, hinge
25 Gasket, air horn
26 Float Bowl Assembly
27 Guide, pump discharge
28 Spring, pump discharge
29 Ball, pump discharge
30 Gasket, throttle body
31 Pump Assembly
32 Spring
33 Throttle Body Ass'y
34 Spring
35 Idle Adjusting Needle
36 Clip, choke rod- upper
37 Rod, choke
38 Clip, choke rod-lower
39 Cam, fast idle
40 Screw
41 Choke Tube Ass'y
42 Nut
43 Packing, choke tube nut
44 Idle Stop Screw
45 Link
46 Pin, hair
47 Screw
48 Gasket, carb. flange
49 Choke Housing Ass'y
50 Welch Plug
51 Screw
52 Lever Assembly
53 Choke Piston
54 Pin
55 Screw
56 Plate, baffle
57 Gasket
58 Stat Cover & Coil Ass'y
59 Retainer
60 Screw

Figure 2. Carburetor Disassembled

01514

REMOVAL

1. Remove flame arrestor.
2. Remove fuel line connection and inlet fuel filter.
3. Remove inlet fuel filter nut from carburetor inlet fuel filter with 1" box wrench or socket. (Figure 2)
4. Remove filter element, spring and 2 gaskets.
5. Clean element by washing in solvent and blowing out.

NOTE: Replace element if flooding occurs.

6. Disconnect fuel and choke heat lines ("BC" model carburetor only) from carburetor.
7. Disconnect throttle rod from throttle lever.
8. Remove 2 carburetor flange-to-manifold stud nuts and lift carburetor off.

DISASSEMBLY (Figure 2)

"BC" CARBURETOR

1. Remove choke rod retaining spring clip and rod from choke shaft lever.
2. Unscrew vacuum tube connector nut from choke housing.
3. Remove 4 bowl cover screws and return spring bracket.
4. Lift cover straight up to prevent damage to floats.
5. Place cover up-ended on a flat surface and remove float hinge pin, floats and float needle. (Figure 3)

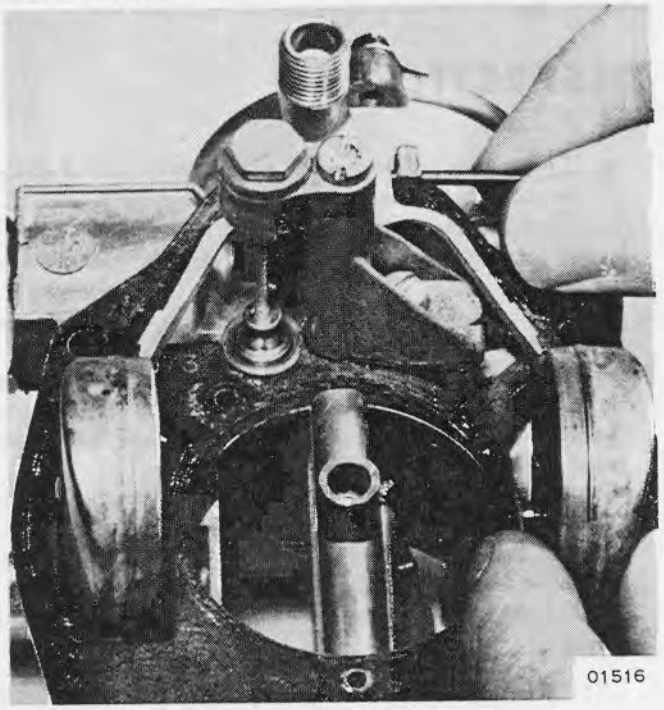


Figure 3. Removing Float

6. Remove carburetor fuel filter inlet nut, gaskets, fuel filter and spring.
7. Remove 3 choke cover attaching screws and retainers, then remove choke cover and thermostatic coil assembly from choke housing.
8. Remove choke cover gasket and baffle plate. (Figure 4)
9. Remove choke shaft lever retaining screw and levers.

NOTE: Choke valve and shaft should not be removed unless shaft is binding or valve is damaged. If either condition exists, disassemble as outlined in Steps 10, 11 and 12. Disregard Steps 10, 11 and 12 if either condition does not exist.

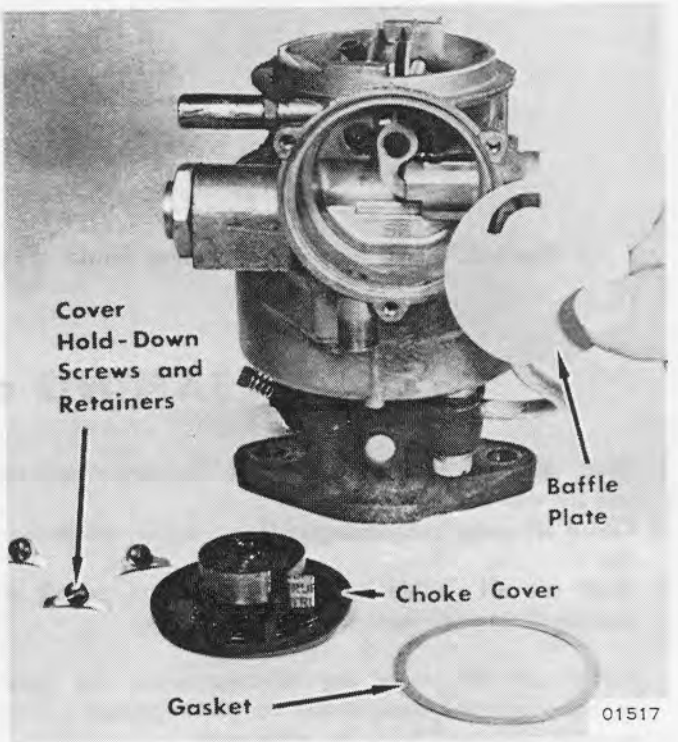


Figure 4. Automatic Choke Disassembly

10. File choke valve screw staked ends level with choke shaft.
11. Remove 2 choke valve plate retaining screws from shaft, remove plate and slide shaft out of air horn by first rotating shaft to remove piston and pin from choke housing.
12. Remove choke housing from bowl cover by removing 2 attaching phillips head screws and gasket.
13. Remove float seat and gasket.
14. Remove main well support, vacuum power piston and spring.
15. Lift off cover gasket.
16. Remove main metering jet and power valve retainer, spring and ball from main well support.
17. While holding accelerating pump plunger all-the-way down in bowl, remove hairpin retainers and pump link from throttle lever and pump arm. Now lift pump assembly from bowl. Place plunger in gasoline or kerosene to prevent leather from drying out.
18. Lift pump return spring from pump well.
19. Remove pump discharge guide (Figure 5) with needle-nose pliers.

20. Carefully remove pump discharge spring and ball by turning bowl upside down.
21. With bowl upside down, remove 2 throttle body attaching screws and gasket.
22. Remove idle mixture needle (adjusting screw) and spring from throttle body.

"B" CARBURETOR (Figures 2, 3 and 5)

1. Remove 4 bowl cover screws.
2. Refer to Steps 4-thru-22 (omitting Steps 7-thru-12) of "BC" carburetor disassembly, immediately preceding.

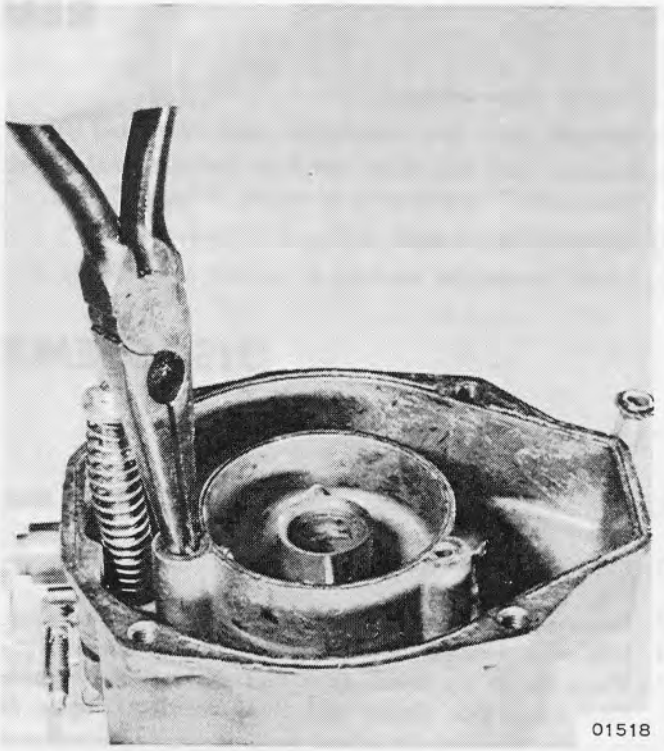


Figure 5. Removing Pump Discharge Guide

CLEANING and INSPECTION

1. Wash all metal parts thoroughly in carburetor solvent and dry with compressed air.
2. Check all parts and passages for clogging and deposits.
3. Blow out all drilled passages with compressed air and check to make sure that they are clean.

   NOTE: Do not, under any circumstances, use wire or other pointed instruments to clean drilled passages or calibrated holes in carburetor.

4. Inspect pump plunger. If leather or its garter expanding spring is damaged in any way, replace plunger assembly. Shake plunger to determine if bypass ball check (inside assembly) is free.
5. To check pump system:
   a. Pour 1½" (38mm) of gasoline into carburetor bowl.
   b. Take pump plunger from can of gasoline or kerosene and slide into pump cylinder.
   c. Place discharge check ball into body.
   d. Raise plunger and press lightly on shaft to expel air from pump passage.
   e. Using a small clean brass rod, hold discharge ball down firmly on its seat.
   f. Again raise plunger and press downward. No fuel should flow past discharge ball or back thru inlet ball in pump assembly.
   g. If pump plunger depresses easily, presence of dirt or damaged check balls is indicated.
   h. Clean passage again and repeat test. If leakage still is present, replace check ball or pump plunger assembly.
6. Check floats for dents and wear on lip and hinge pin. Also check cover for wear in hinge pin holes.
7. Check float needle. If wear is noted on float needle, install new float needle assembly which consists of matched and tested needle and seat and new fiber washer.
8. Check power piston for burrs or other damage. Piston must move freely in cover bore.
9. Check throttle arm for looseness on shaft and for excessive wear at throttle rod connection.
10. Check throttle shaft for excessive looseness in throttle body.

    NOTE: Any damage or excessive wear in throttle arm or shaft requires replacement of throttle body assembly. This is due to the close tolerance of throttle valve fit required and the fact that idle discharge and spark advance holes are drilled in relation to a proper fitting valve.

11. Check choke valve for freedom of operation in cover when assembled.
12. Check bronze fuel filter for chips or cracks.

REASSEMBLY

1. Install idle mixture needle (adjusting screw) and spring, finger tight, in throttle body. As a temporary idle adjustment, back needle out 2 turns.
2. Using a new throttle body gasket, attach bowl to throttle body, securing with 2 screws and lockwashers, and tighten screws evenly and securely.
3. Place pump return spring into pump well and center spring by depressing with finger.
4. Install pump plunger assembly, carefully insert leather portion into bowl and connect pump link to throttle lever and pump arm. Install hairpin retainers at both upper and lower ends of link.
5. Drop large steel ball into pump discharge cavity of bowl and place spring on top of ball. (Figure 6)
6. Insert index end of pump discharge guide into spring and press guide down until flush with bowl surface.
7. Place new air horn gasket on air horn.
8. Place power piston spring and power piston in air horn cavity and attach main well support to cover with a screw and lockwasher.
9. Install main metering jet and tighten securely.
10. While holding power piston stem down, install power ball, spring and plug and tighten securely.
11. Install a new fiber washer in float needle seat well and install seat and float needle.
12. Attach float and hinge pin.

NOTE: Float tang must face cover.

13. Adjust float setting as outlined under "Adjustments, Float Drop and Float Level", following.
14. Place cover on bowl. Install attaching screws and lockwashers and return spring bracket and tighten securely.
15. Install fuel filter element spring and insert fuel filter element with cone facing opening. Position inner gasket and outer gasket and secure with fuel filter inlet nut. (Figure 1)

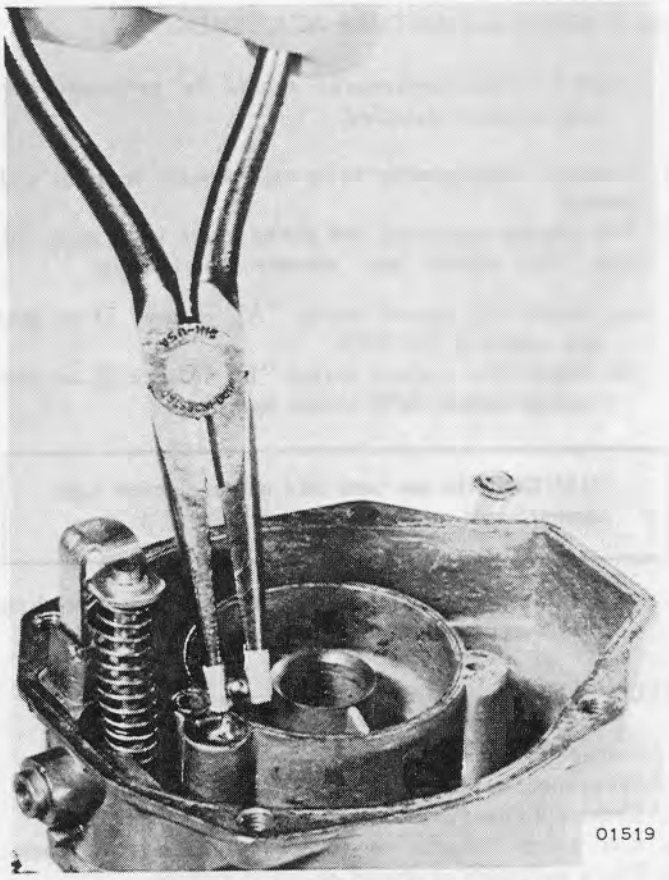


Figure 6. Installing Pump Discharge Ball

16. On "BC" carburetor only: Reverse disassembly Steps 7-thru-12 and install and tighten vacuum tube connector nut to choke housing.
17. On "BC" carburetor only: Attach choke rod to choke shaft lever and install rod retaining spring clip.

INSTALLATION

1. Place carburetor in position with gasket on manifold studs and install retaining nuts. Tighten evenly and securely.

   NOTE: Be sure that gasket is positioned correctly. All vacuum holes must be open.

2. Connect fuel line to carburetor.
3. Connect throttle rod to throttle shaft lever.
4. On "BC" carburetor only: Connect choke heat tube to choke housing.
5. Adjust idle speed and mixture as outlined under "Adjustments".
6. Refer to "Adjustments" for all necessary carburetor adjustments.

   NOTE: It is recommended that all adjustments to be made, other than those mentioned, be done upon completion of assembly and installation of carburetor.

ADJUSTMENTS for MODEL "B" CARBURETOR

IDLE SPEED and MIXTURE ADJUSTMENT

NOTE: This adjustment should be performed with flame arrestor installed.

1. Connect a tachometer to a coil primary terminal and ground.
2. With engine operating and choke valve wide open, adjust idle speed and mixture as follows:
   a. Adjust idle speed screw "A" (Figure 7) to give idle speed of 500 RPM.
   b. Adjust idle mixture screw "B" (Figure 7) to give highest steady RPM at idle speed.

CAUTION: Do not turn idle mixture screw tight against seat, or damage may result.

   c. If necessary, repeat Steps "a" and "b", preceding, for "fine" adjustment.

FLOAT LEVEL ADJUSTMENT (Figure 8)

1. Remove carburetor flame arrestor from air horn.
2. Disconnect fuel line at carburetor.
3. Remove 4 cover attaching screws.
4. Lift cover straight up to prevent damage to floats.
5. Place assembly up-ended on a flat surface.

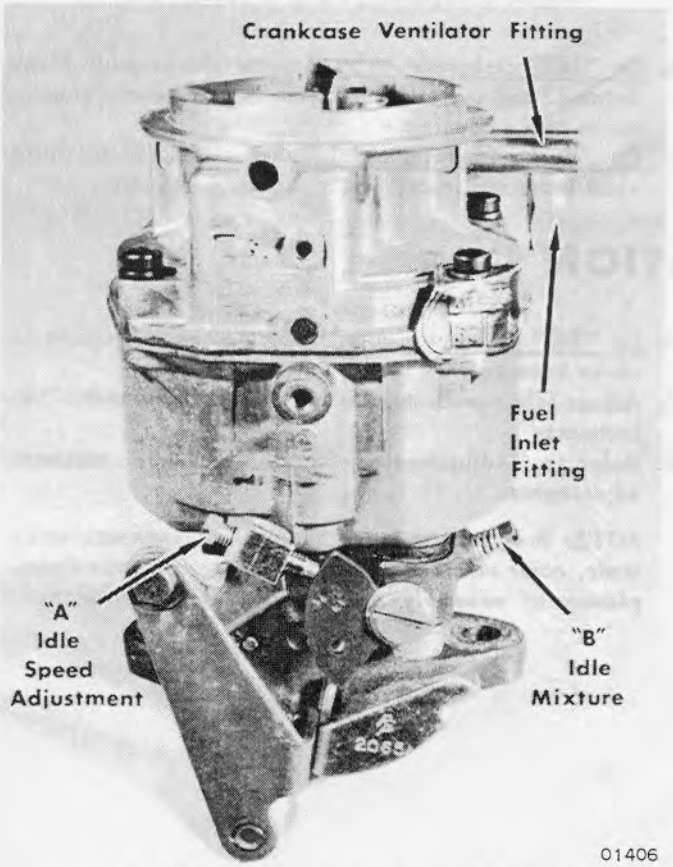


Figure 7. Idle Speed and Mixture Adjustment

6. Bend float arms vertically, if necessary. (Figure 8)
7. Carefully bend float arms horizontally so that each float is centered in the gasket. Recheck level adjustment. Distance from air horn gasket to top of each float is 1-9/32" (32.6mm).

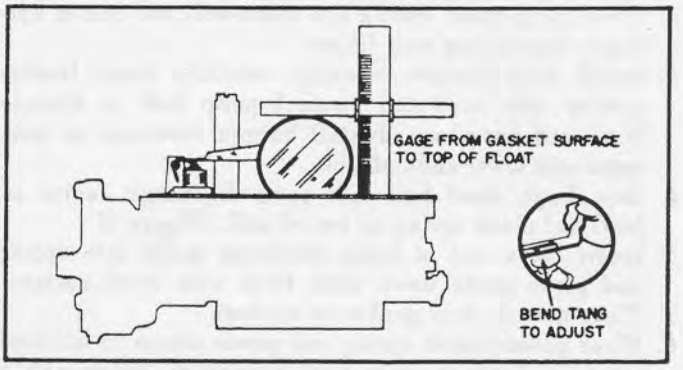


Figure 8. Float Level Adjustment

FLOAT DROP ADJUSTMENT (Figure 9)

To ensure sufficient entry of fuel under high speed operation, it is necessary to check and adjust float drop.

1. Hold cover assembly in upright position and let floats suspend freely.
2. Carefully bend float tang, only if necessary, at rear of float assembly so that float is 1-3/4" (44.45mm) below gasket surface.

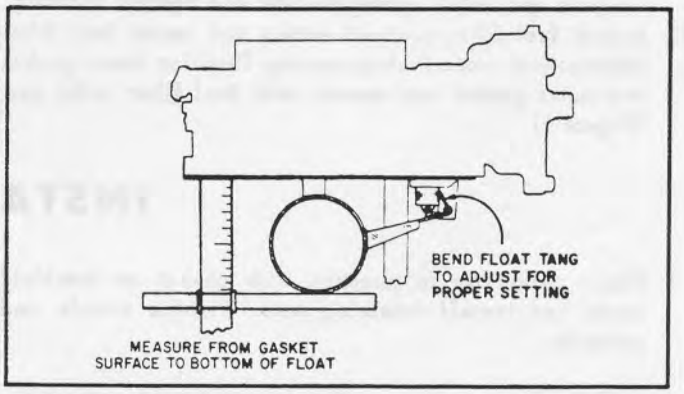


Figure 9. Float Drop Adjustment

AIR HORN INSTALLATION

1. Install 4 attaching screws and tighten screws securely. (Figure 10)
2. Connect fuel line to carburetor fuel filter.
3. Replace carburetor flame arrestor and check and adjust idle speed and idle mixture, if necessary.

INLET FUEL FILTER

REMOVE AND REPLACE

1. Remove fuel line connection and inlet fuel filter.

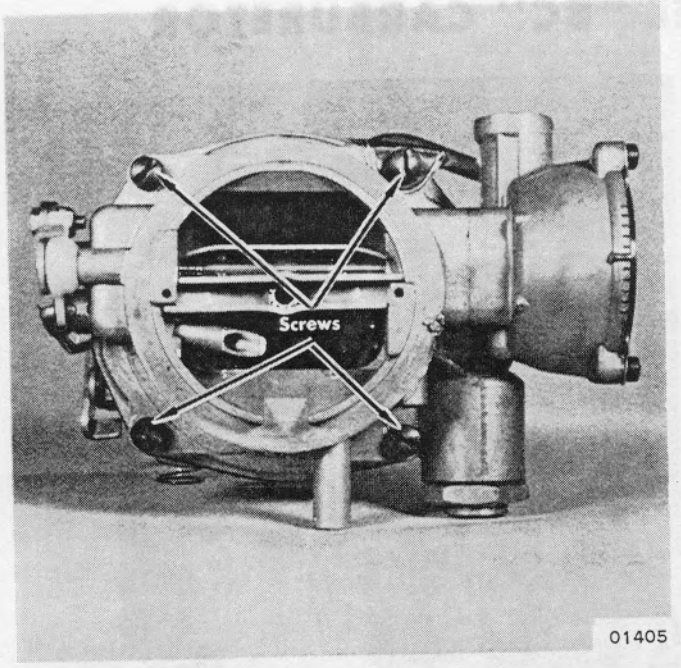


Figure 10. Air Horn Installed

2. Remove inlet fuel filter nut from carburetor inlet fuel filter with a 1" box wrench or socket. (Figure 11)
3. Remove filter element, spring and 2 gaskets.
4. Clean element by washing in solvent and blowing out.

NOTE: Replace element if flooding occurs.

5. Reverse procedure for replacement.

NOTE: Proper installation of fuel filter element is important. Small end of cone faces inlet fuel filter nut.

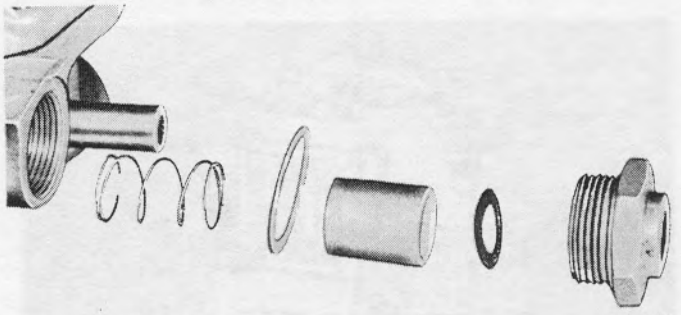


Figure 11. Carburetor Fuel Filter

ADJUSTMENTS for MODEL "BC" CARBURETOR

INLET FUEL FILTER

REMOVE and REPLACE

Same as Model "B" carburetor, preceding.

IDLE SPEED and MIXTURE ADJUSTMENT (Figure 12)

Same as Model "B" carburetor, preceding

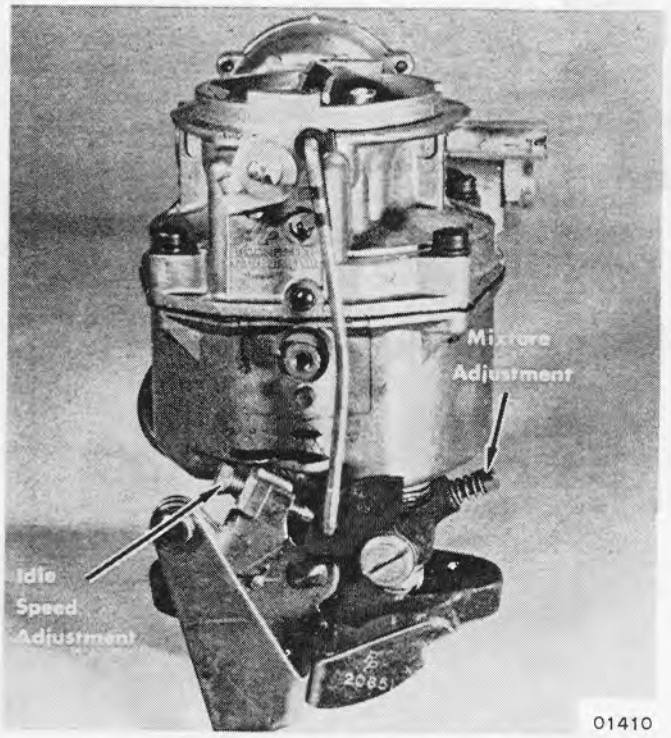


Figure 12. Idle Speed and Mixture Adjustment

AUTOMATIC CHOKE ADJUSTMENT

1. Adjust automatic choke by loosening 3 small screws which secure bakelite choke cover.
2. With cover loosened, insert screwdriver and set scribe mark on cover in line with index mark on choke housing.
3. Tighten 3 cover screws.

CHOKE ROD SETTING

1. No adjustment is necessary, except to make sure that idle screw contacts cam when choke valve is completely open or closed.
2. If screw drops off cam in either choke valve position, bend choke rod to position cam correctly. (Figure 13)

UNLOADER ADJUSTMENT

1. Place throttle in wide open position.
2. Using Tool J-9580, check that small step of gauge .230/.270 slides freely between lower edge of choke valve or bore of carburetor. (Figure 14)

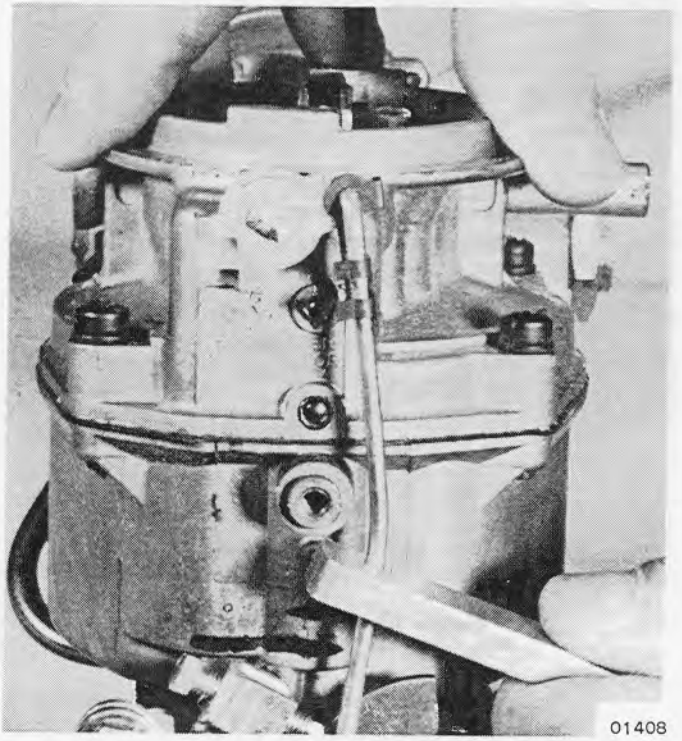


Figure 13. Adjusting Choke Rod

3. If necessary, bend tang to throttle lever to obtain necessary clearance.

FLOAT LEVEL ADJUSTMENT

1. Remove carburetor flame arrestor.
2. Disconnect fuel line at carburetor fuel filter inlet.

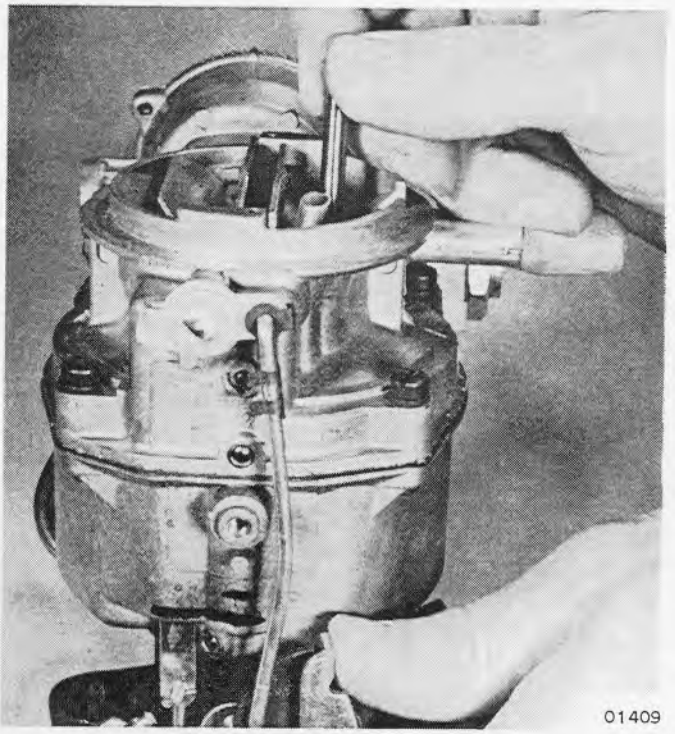


Figure 14. Checking Unloader

3. Unscrew fitting on choke vacuum tube at cover.
4. Disconnect heat pipe from choke to exhaust manifold "stove".
5. Remove tube from carburetor clean air intake tube.
6. Disconnect choke rod from choke lever by removing lever to rod spring clip.
7. Remove 4 cover screws and lockwashers.
8. Lift cover assembly straight up to prevent damage to floats.
9. Place cover assembly with cover gasket in an up-ended position on a flat surface.
10. Bend float arms vertically, if necessary. (Figure 15)
11. Carefully bend float arms horizontally so that each float is centered in the gasket. Recheck level adjustment. Distance from air horn gasket to top of each float is 1-9/32" (32.6mm).

FLOAT DROP ADJUSTMENT

To ensure sufficient entry of fuel under high speed operation, it is necessary to check and adjust float drop.

1. Hold cover assembly in upright position and let floats suspend freely.
2. Carefully bend float tang, only if necessary, at rear of float assembly so that float is 1-3/4" (44.45mm) below gasket surface.

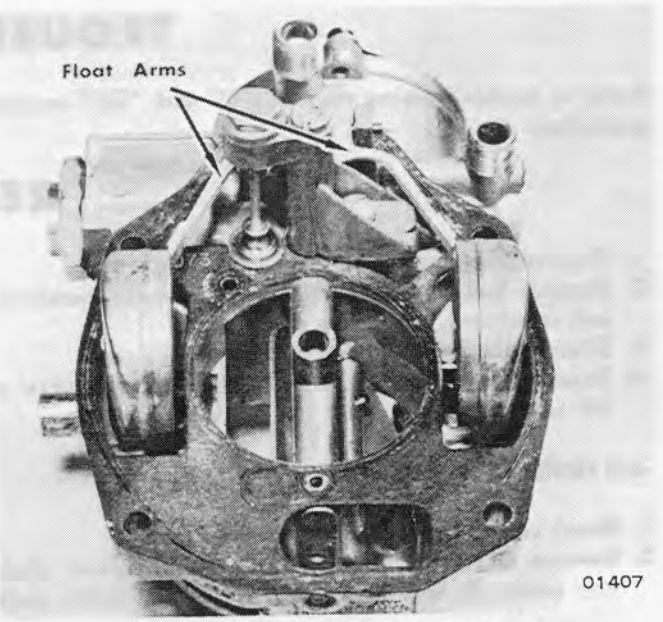


Figure 15. Checking Float Centering

MODEL 2GC CARBURETOR

DESCRIPTION

The 2GC is a 2-bore carburetor with automatic choke. The major portion of calibrated metering parts are contained in the venturi cluster (located in float bowl) and may be serviced readily by removing air horn assembly. Idle tubes and main discharge nozzles are pressed into venturi clusters and need not be serviced separately. Pump jets are part of venturi cluster also. Power restrictions are pressed into fuel bowl at factory, thereby making replacement unnecessary.

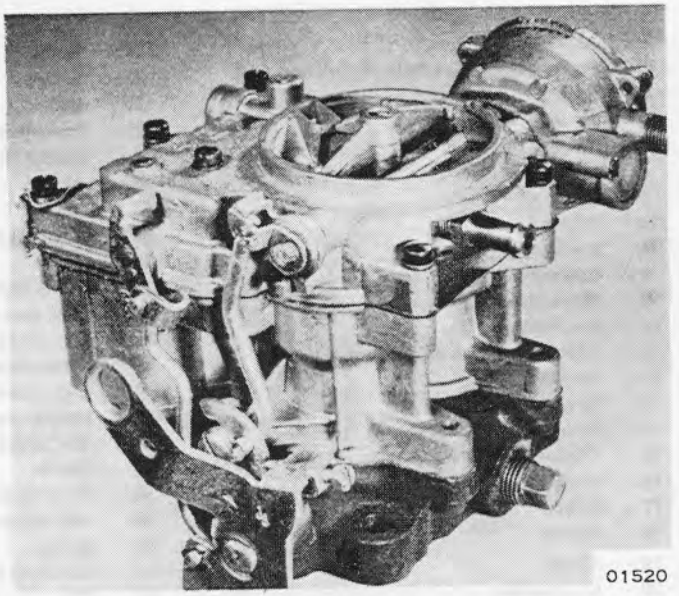


Figure 1. 2GC Carburetor

PRECAUTIONS

Before making carburetor adjustments, be sure that carburetor-to-manifold and manifold-to-cylinder head bolts are tight to prevent air leaks. Engine must be warmed up to operating temperature, or carburetor misalignment will occur. Allow engine to run for at least 15 minutes.

NOTE: Warmup is not required for float level and pump lever operations.

TROUBLESHOOTING

Refer to troubleshooting chart in "B" and "BC" section, preceding.

NOTE: Refer to "Specifications" Section 8 for current data.

REMOVAL

1. Remove flame arrestor.
2. Remove fuel line connection, choke heater connection and crankcase ventilation connection.
3. Disconnect throttle rod from throttle.
4. Remove 4 carburetor flange-to-manifold stud nuts and lift carburetor off.

AIR HORN REMOVAL

1. Mount carburetor on correct holding fixture.
2. Remove 3 retainer screws and retainers from choke stat cover. Remove stat cover, gasket and baffle plate. (Figure 3)

(Continued on Page 4B-14)

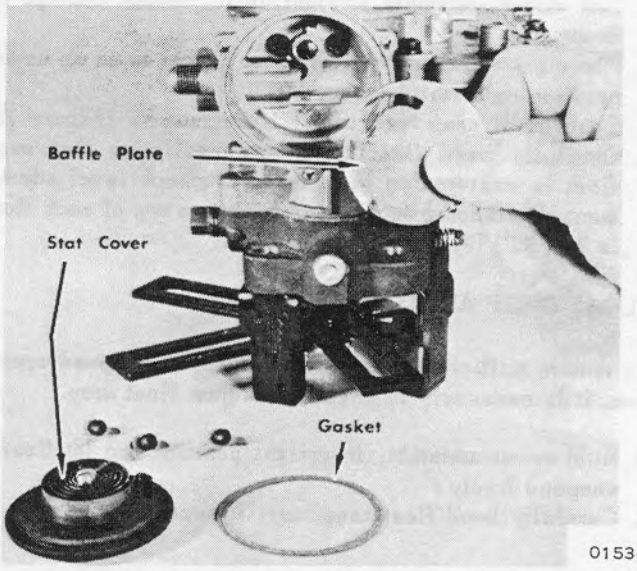


Figure 2. Removing Choke Stat Cover

1 - Air Horn
2 - Power Piston Assembly (6-Cyl. and 140)
3 - Gasket
4 - Screw
5 - Screw
6 - Lockwasher
7 - Nut
7A - Filter
7B - Spring
8 - Gasket
9 - Float Assembly
10 - Pin, hinge
11 - Inlet Needle and Seat Assembly
12 - Gasket
13 - Strainer
14 - Float Bowl Assembly
15 - Venturi Cluster Assembly
16 - Gasket
17 - Screw
18 - Gasket
19 - Screw
20 - Lockwasher
21 - Guide
22 - Spring
23 - Ball
24 - Power Valve Assembly (6-Cyl. and 140)
25 - Gasket (6-Cyl. and 140)
26 - Jet
27 - Strainer
28 - Lever, pump
29 - Screw
30 - Pump Shaft and Lever Assembly
31 - Rod, pump
32 - Clip, retainer
33 - Pump Assembly
34 - Clip, retainer
35 - Spring, pump return
36 - Ball, check
37 - Gasket
38 - Throttle Body Assembly
39 - Idle Adjusting Needle
40 - Spring
41 - Idle Stop Screw
42 - Clip
43 - Gasket
44 - Screw
45 - Lockwasher
46 - Cam, fast idle
47 - Screw
48 - Rod, choke
49 - Choke Lever and Collar Assembly
50 - Choke Shaft Assembly
51 - Valve, choke
52 - Screw
53 - Choke Housing Assembly
54 - Gasket
55 - Screw
56 - Lever Assembly
57 - Screw
58 - Choke Piston
59 - Pin
60 - Plug, ball
61 - Welch Plug
62 - Plate, baffle
63 - Gasket
64 - Stat Cover and Coil Assembly
65 - Screw
66 - Retainer

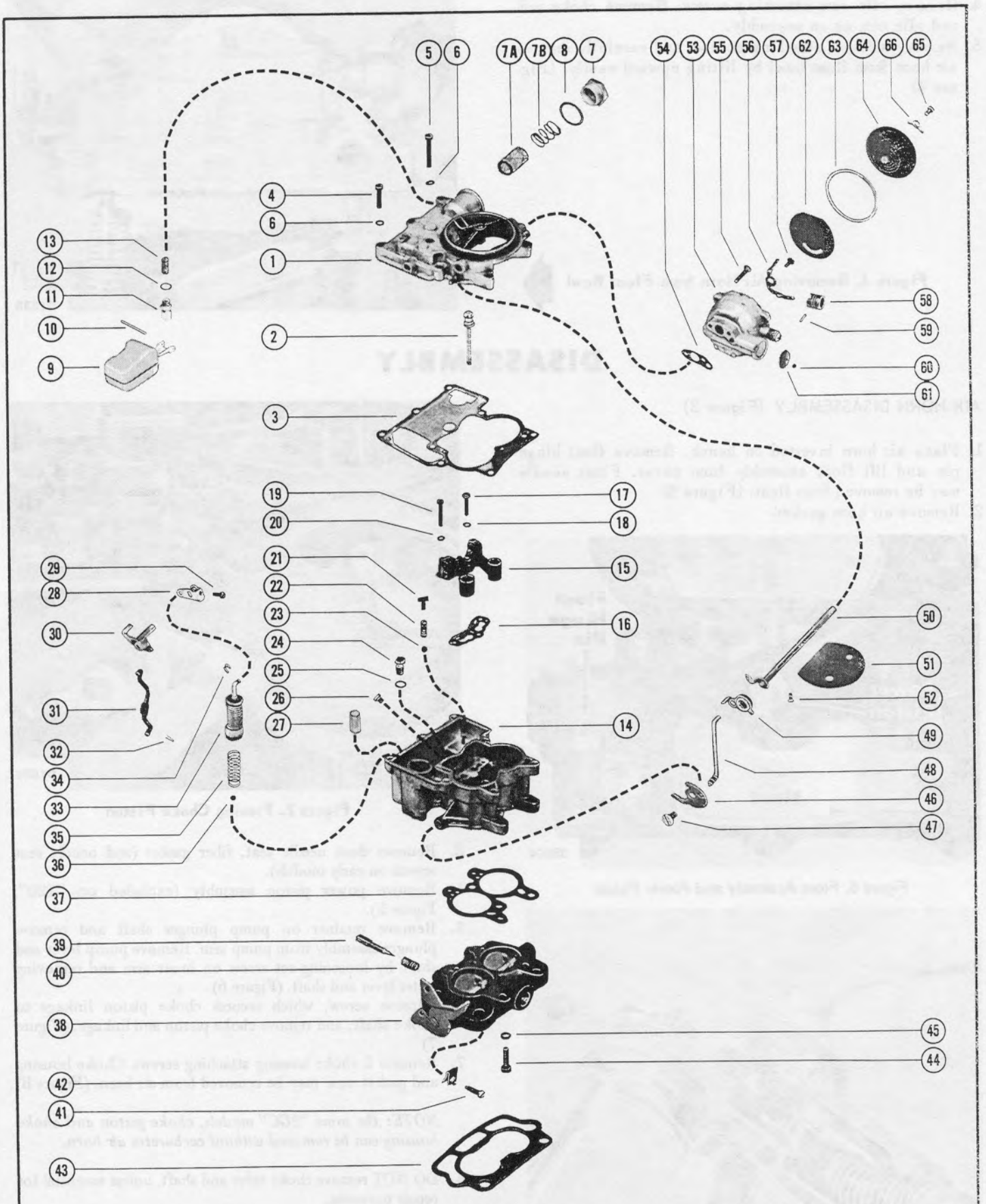


Figure 3. "2GC" Carburetor Assembly

3. Remove pump rod by removing retaining clips.
4. Remove idle cam attaching screw. Remove choke rod and idle cam as an assembly.
5. Remove air horn attaching screws and carefully remove air horn from float bowl by lifting upward easily. (Figure 4)

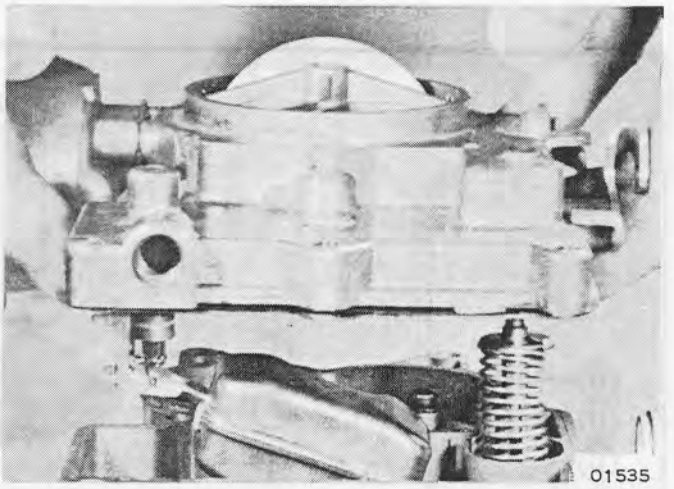


Figure 4. Removing Air Horn from Float Bowl

DISASSEMBLY

AIR HORN DISASSEMBLY (Figure 3)

1. Place air horn inverted on bench. Remove float hinge pin and lift float assembly from cover. Float needle may be removed from float. (Figure 5)
2. Remove air horn gasket.

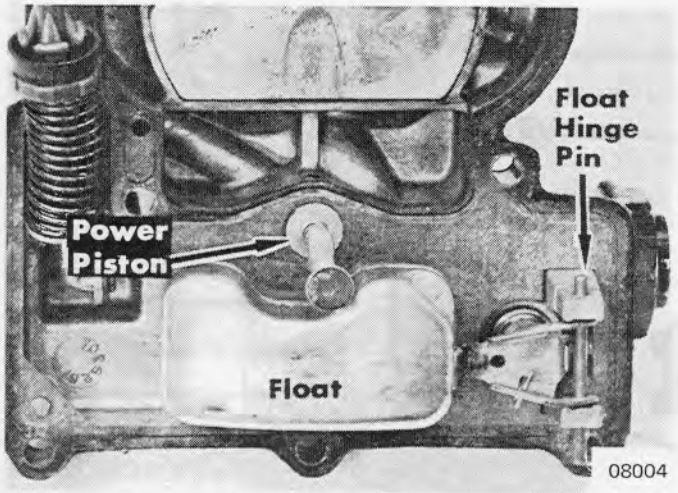
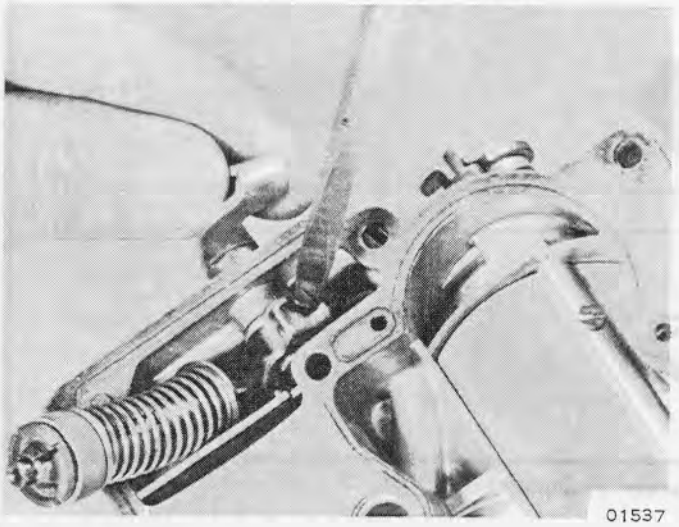


Figure 5. Float Assembly and Power Piston



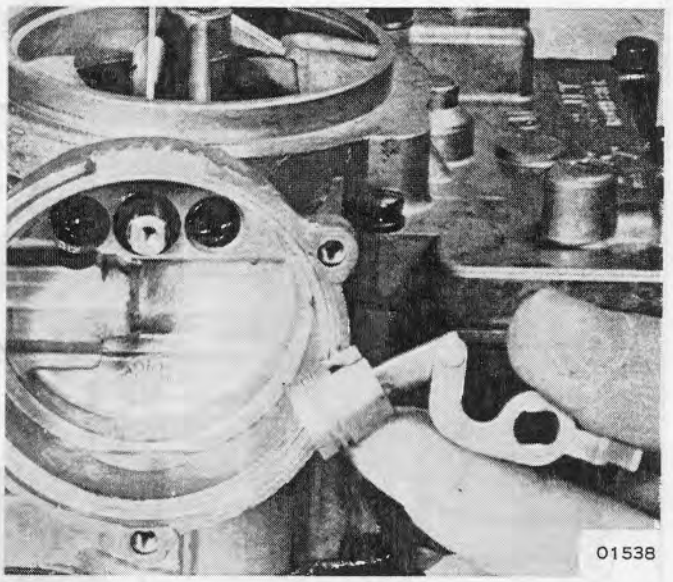


Figure 7. Freeing Choke Piston

3. Remove float needle seat, fiber gasket (and needle seat screen on early models).
4. Remove power piston assembly (excluded on "120", Figure 5).
5. Remove retainer on pump plunger shaft and remove plunger assembly from pump arm. Remove pump lever and shaft by loosening set screw on inner arm and removing outer lever and shaft. (Figure 6)
6. Remove screw, which secures choke piston linkage to choke shaft, and remove choke piston and linkage. (Figure 7)
7. Remove 2 choke housing attaching screws. Choke housing and gasket now may be removed from air horn. (Figure 8)

   NOTE: On some "2GC" models, choke piston and choke housing can be removed without carburetor air horn.

8. DO NOT remove choke valve and shaft, unless essential for repair purposes.

Figure 6. Loosening Set Screw

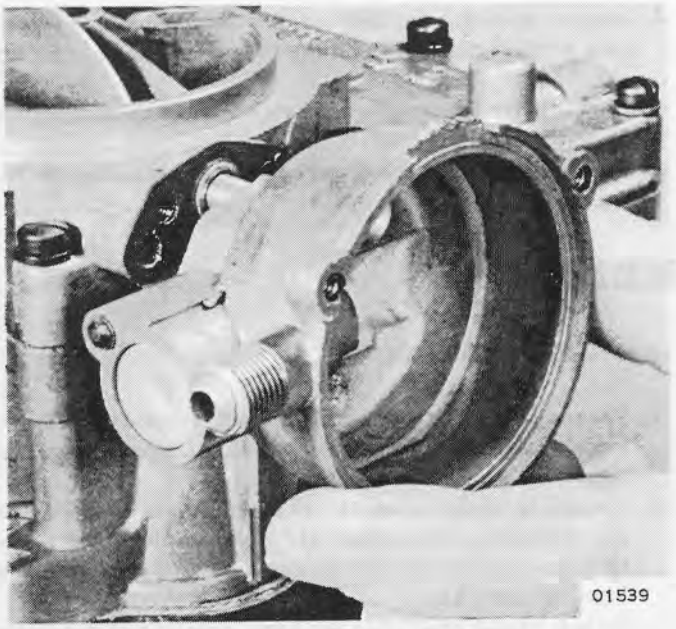


Figure 8. Removing Choke Housing

9. Remove 2 choke valve retaining screws (file off staked ends). Remove choke valve.

FLOAT BOWL DISASSEMBLY

1. Remove pump plunger return spring (and check ball on later models) from pump well.
2. Remove pump inlet screen on later models.
3. Remove main metering jets. (Figure 9)
4. Remove power piston check valve and gasket (excluded on "120", Figure 9).
5. Remove 3 attaching screws on top of venturi cluster, then remove cluster and gasket. Center cluster screw has smooth shank and fiber gasket for accelerator pump fuel by-pass.
6. Remove discharge ball spring T-shaped retainer with a pair of long nose pliers. Remove pump discharge spring and steel discharge ball. (Figure 10)
7. Invert carburetor and remove 3 throttle body to bowl attaching screws. Remove throttle body and throttle body to bowl gasket.

THROTTLE BODY DISASSEMBLY

1. Remove idle mixture adjusting needles and springs.
2. Remove fast and slow screws from throttle lever, if replacement is necessary.

No other disassembly of throttle body is needed. Never remove throttle valves, as idle and spark holes are drilled in direct relation to location of throttle valves. Removal of throttle valves will upset this location. Throttle body is serviced as a complete unit with throttle valves intact.

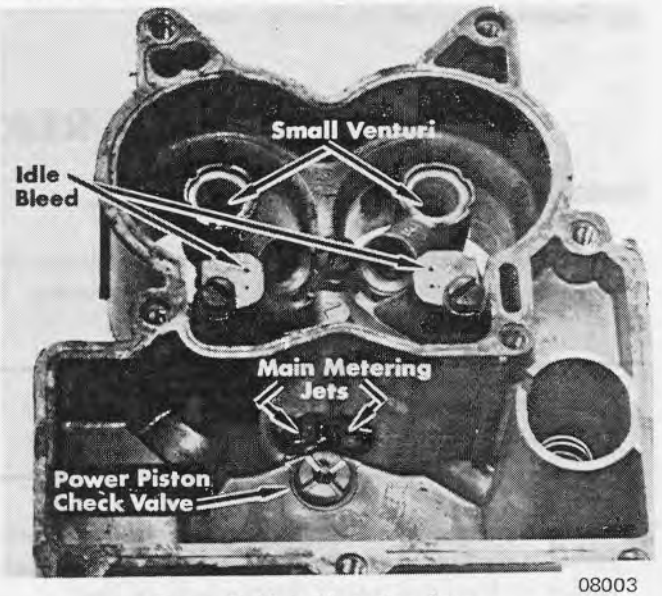


Figure 9. Main Metering Jets

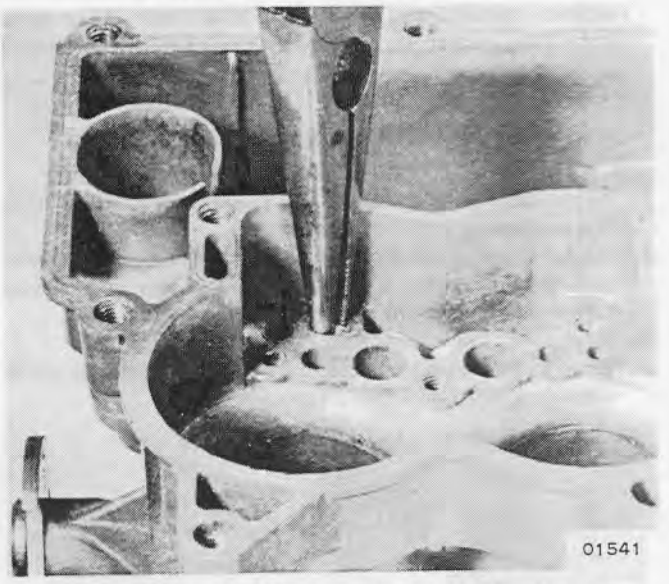


Figure 10. Removing Pump Discharge Spring Retainer

CLEANING and INSPECTION

Dirt, gum, water or carbon contamination in or on exterior moving parts of carburetor often are responsible for unsatisfactory performance. For this reason, efficient carburetion depends upon careful cleaning and inspection while servicing.

1. Thoroughly clean carburetor castings and metal parts in fresh cleaning solvent.

CAUTION: Never immerse choke stat cover and pump plunger in carburetor cleaner. Wash pump plunger in clean stoddard solvent or equivalent.

2. Blow all passages in castings dry with compressed air and blow off all parts until they are dry. Make sure all jets and passages are clean. Do not use wires or drills for cleaning fuel passages or air bleeds.
3. Check all parts for wear. If wear is noted, replace defective parts. Note especially the following:
   a. Check float needle and seat for wear. If worn, replace assembly.
   b. Check float hinge for wear and float for dents and distortion. Check floats for fuel leaks by shaking.
   c. Check throttle and choke shaft bores for wear and out-of-round in air horn casting and throttle body.

d. Inspect idle adjusting needles for burrs or grooves and misalignment. Replace if defective.
e. Replace idle cam, if wear is noted, as wear may alter set idle speed during choke operation.
f. Replace pump plunger leather, if damaged or worn.
g. Inspect pump well in bowl for wear.
4. Inspect gaskets for hard or brittle appearance or for torn or distorted edges. Replace, if any such condition is noted.
5. Check filter screens for dirt or lint. Clean and replace if distorted or plugged.
6. Replace any parts that may be loose or damaged in cluster casting.

REASSEMBLY

THROTTLE BODY REASSEMBLY

1. Screw idle mixture adjusting needles and springs into throttle body until finger-tight. Back out screw 1½ turns as a temporary idle adjustment.

CAUTION: Do not force idle needle against seat, or damage may result.

2. Install fast and slow idle screws and springs in throttle lever, if removed. Invert bowl, place new throttle body gasket on bowl and install throttle body on bowl.
3. Install throttle body to bowl attaching screws and tighten evenly and securely. Make sure that screw holes in gasket line up with screw holes in throttle body.

FLOAT BOWL REASSEMBLY

1. Drop pump discharge check ball (steel) into discharge hole. Replace spring and T-shaped retainer.
2. Replace venturi cluster and gasket. Install cluster screws and tighten evenly and securely. Make sure that center screw is fitted with red fibre gasket. (Figure 11)
3. Replace main metering jets.
4. Place gasket on power piston check valve and install check valve (excluded on "120", Figure 9).

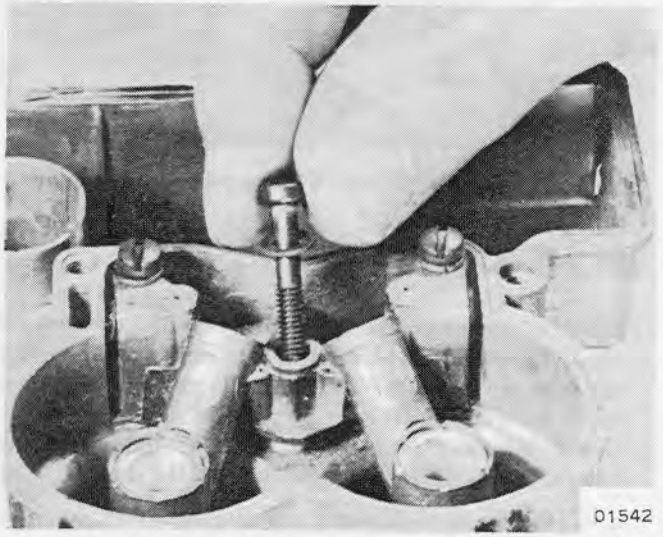


Figure 11. Center Screw and Gasket

5. Install pump inlet screen and inlet check ball on later models. Install pump return spring and center spring in well by pressing downward with finger. (Figure 12)

AIR HORN REASSEMBLY

1. Place new choke housing gasket in position on air horn and install choke housing with 2 attaching screws tightened evenly and securely.
2. Assemble choke piston to choke shaft and link assembly, retaining with piston pin. Piston pin and flat section on side of choke piston should face toward air horn. (Figure 13)
3. Install choke shaft into air horn, rotating choke piston until it enters choke piston bore in choke housing.
4. Install choke valve on choke shaft with letters "RP" facing up. Install 2 choke valve retaining screws, but do not tighten securely until choke valve is centered.

NOTE: Center choke valve on choke shaft by installing choke lever and collar assembly and trip lever. Maintain .020" (.51mm) clearance between choke lever and air horn casting. Tighten choke valve screw and stake lightly in place.

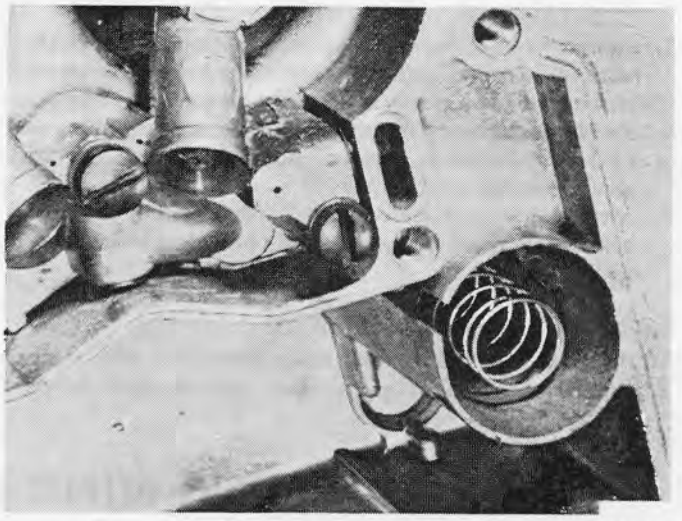


Figure 12. Pump Return Spring Installed 01543

5. Install outer pump lever and inner pump arm to bowl cover and tighten set screw.
6. Attach pump plunger assembly to inner arm with pump shaft pointing inward and install horseshoe retainer. (Figure 14)
7. Install screen on float needle seat (on early models) and assemble float needle seat and gasket to air horn. Tighten securely.
8. Install air horn gasket on air horn.
9. Install power piston assembly (excluded on "120", Figure 5). Peen air horn housing around power piston to retain piston in housing.

10. Attach float needle to float, carefully position float and insert hinge pin.
11. Adjust float as outlined in "Adjustments", following.
12. Place air horn on float bowl, making sure that accelerator pump plunger is positioned and will move freely. Lower cover gently straight down to ensure proper installation.
13. Install and tighten air horn screws evenly and securely.
14. Install accelerator pump rod and retainers.

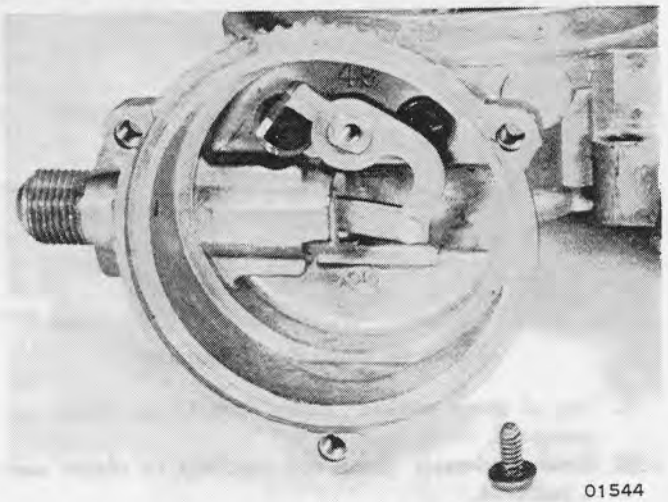


Figure 13. Positioning Piston

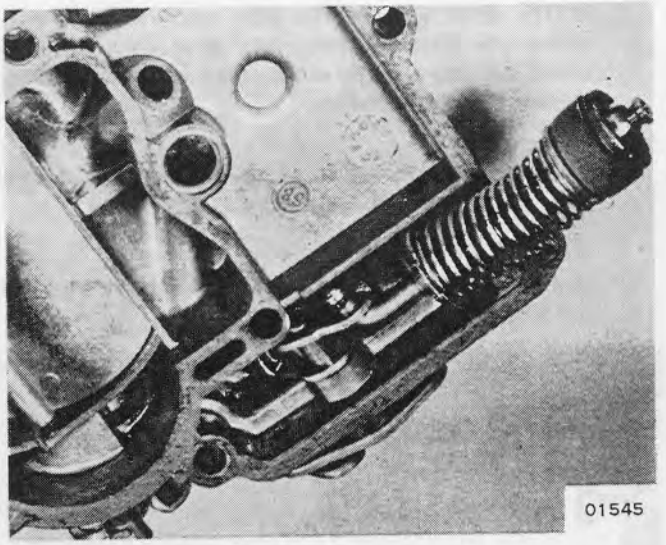


Figure 14. Attaching Pump Plunger

CHOKE REASSEMBLY

1. Place baffle plate and choke stat cover gasket into position and install choke stat cover. Rotate cover until correct index marking is aligned. Attach 3 retainers and screws to choke housing and tighten securely.
2. Install choke rod in idle cam and choke counterweight lever. Install idle cam and choke rod as assembly.
3. Attach idle cam to bowl (with letters "RP" facing outward) and choke lever to air horn (with tang facing outward). (Figure 15)

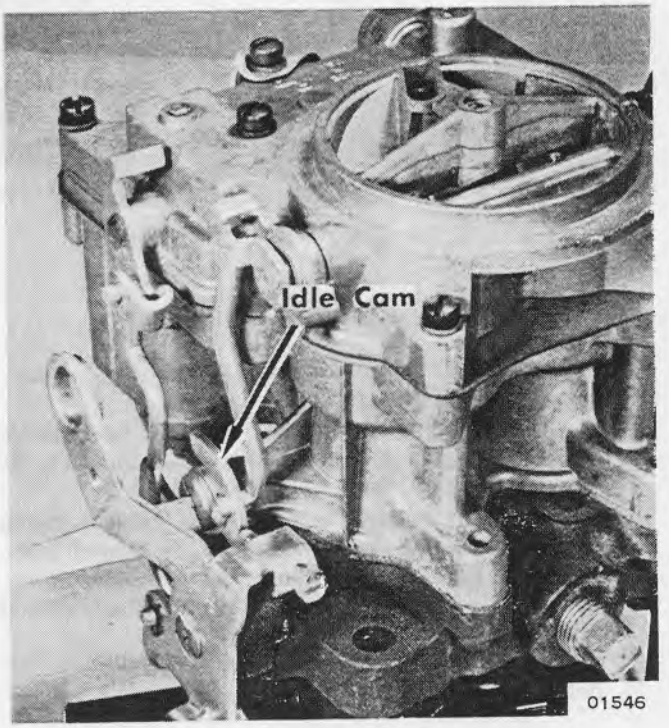


Figure 15. Attaching Idle Cam

INSTALLATION

1. Throttle flange body and intake manifold gasket surfaces must be clean.
2. Install new gasket and carburetor.
3. Install 4 nuts and tighten evenly.
4. Install choke heat tube and fuel line.
5. Install throttle rod and return spring.
6. Install flame arrestor.
7. Adjust idle speed and mixture as outlined in "Adjustments", following.

ADJUSTMENTS

IDLE SPEED and MIXTURE ADJUSTMENTS

NOTE: Carburetor idle mixture screws have a combination 1/4" hexagon and screwdriver slot to ease adjustment.

1. Connect tachometer and vacuum gauge to engine.
2. With a thoroughly warmed-up engine, check that choke is fully off (open).
3. Start engine and allow to idle. Adjust idle speed screw (Figure 16) to 475 RPM.
4. Adjust each idle mixture screw (Figure 16) separately to give peak vacuum and RPM indications on tachometer and vacuum gauge.

NOTE: Make approximate idle mixture adjustment by setting idle mixture screws lean to moderate rough idle, which will give a slight vacuum and speed loss, then back screws out (enrich) ¼-turn.

IMPORTANT: Do not turn idle mixture screws tightly against stop, or needle seat will be damaged.

5. Shut off engine and remove tachometer and vacuum gauge.
6. Test boat to check performance.

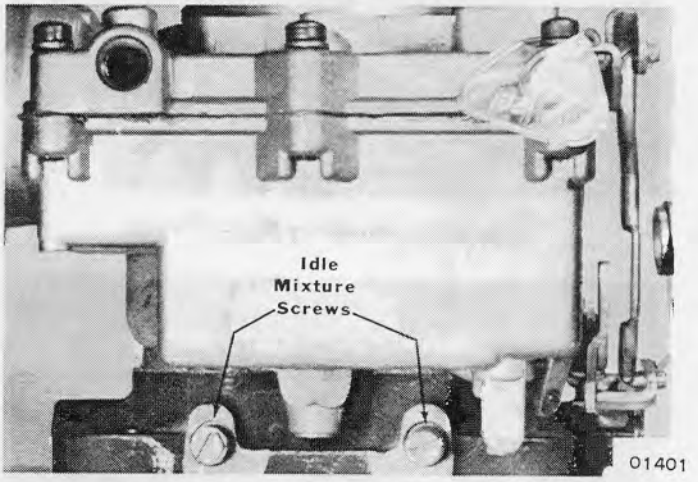


Figure 16. Idle Speed and Mixture Adjustment

FLOAT LEVER and DROP ADJUSTMENTS

1. Remove bowl cover with gasket from carburetor as described under "Disassembly", preceding.
2. Invert cover on a flat surface. Distance from air horn gasket to toe of float at sharp edge of seam should be 5/8" (16mm). Bend float hinge arm as required.
3. Hold bowl in upright position and measure distance (1-29/32" [48.6mm]) from gasket to bottom of float, as shown in Figure 17. Bend tang at end of float hinge arm to obtain correct drop and recheck both settings after this adjustment.
4. Install bowl cover as outlined under "Reassembly".
5. Readjust idle mixture.

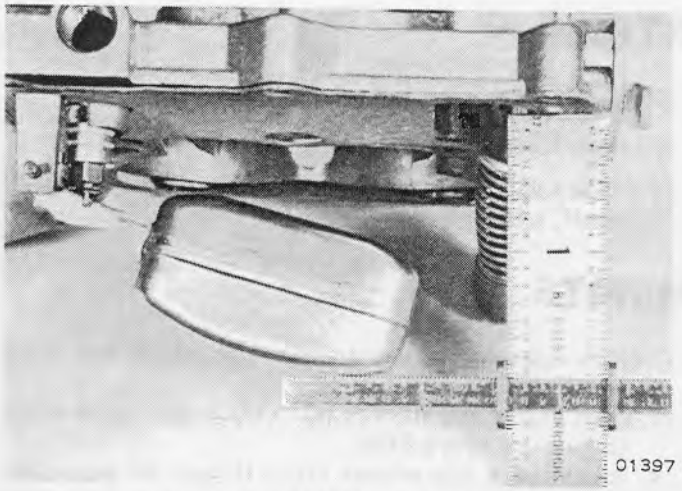


Figure 17. Float Drop Adjustment

PUMP ROD ADJUSTMENT

1. Back off idle screw until throttle valves are completely closed.
2. While holding throttle valves closed, check distance 1-7/32" (5.56mm) from top of air horn to top of pump rod with float gauge, as shown in Figure 18.

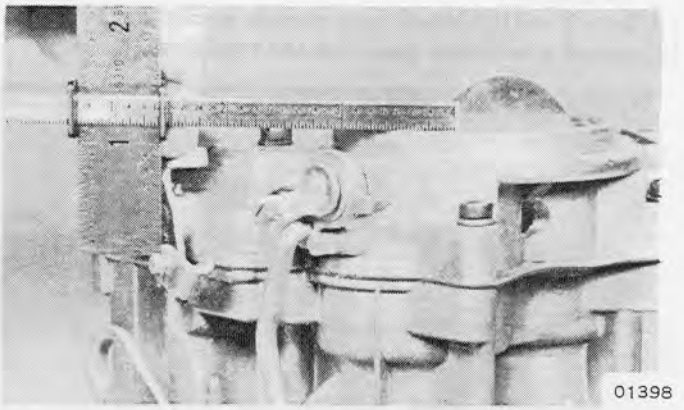


Figure 18. Pump Rod Alignment

3. Leg of gauge marked "Pump" should just touch top of pump rod.
4. Bend accelerator pump rod carefully to obtain correct adjustment.

AUTOMATIC CHOKE ADJUSTMENT

Normal setting of choke is such that scribed mark on cover is in line with long case mark on choke housing casting.

CHOKE ROD ADJUSTMENT

No adjustment of fast idle speed is provided.

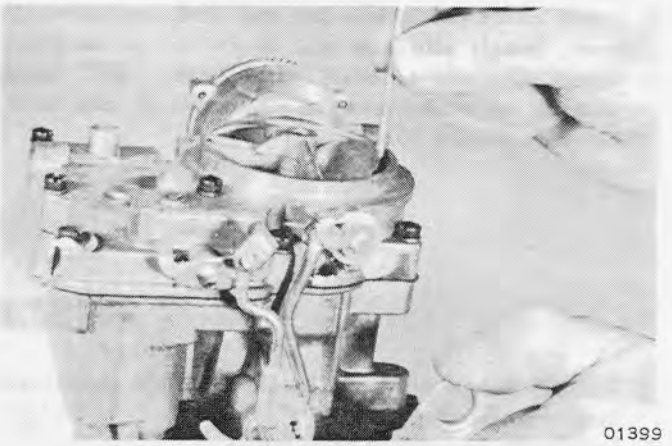


Figure 19. Unloader Adjustment

UNLOADER ADJUSTMENT

Check and make any necessary correction of unload adjustment as follows:

1. Place throttle in wide-open position.
2. Using .160" gauge, see if large end of gauge just slides freely between upper edge of choke valve and bore of carburetor. (Figure 19)
3. If necessary, bend tang of throttle lever to obtain necessary clearance.

MODEL 4GC CARBURETOR

DESCRIPTION

Model 4GC carburetor is a 4-bore, down-draft type which provides the advantage of two 2-bore carburetors in one unit. Carburetor is divided into a primary side and a secondary side. Primary side controls metering to engine throughout idle and part throttle range. Secondary side is a supplementary 2-bore carburetor which feeds extra air and fuel to engine when needed for power requirements. The 4-bore carburetor has a concentric float bowl which allows correct fuel level to be maintained during cornering. The major portion of calibrated metering parts are contained in venturi clusters (located in float bowl) and may be serviced by removing air horn assembly. Idle tubes and main discharge nozzles are pressed into venturi cluster and need not be serviced separately. Power restrictions and pump jets are pressed in, making individual replacement unnecessary.

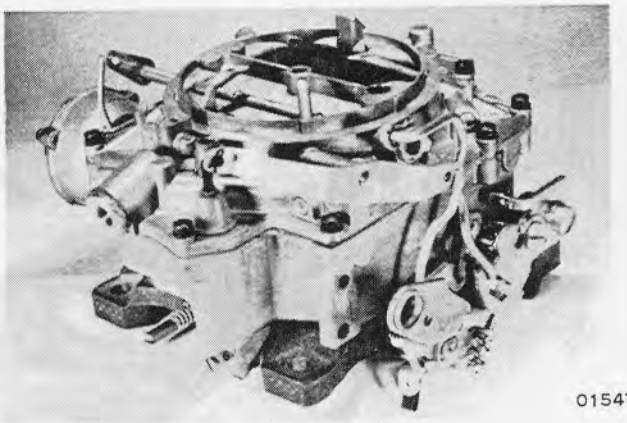


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Figure 1. 4GC Carburetor

PRECAUTIONS

Before making carburetor adjustments, be sure that carburetor-to-manifold and manifold-to-cylinder head bolts are tight (to prevent air leaks). Warm up engine to operating temperature (at least 15 minutes), or carburetor misalignment will occur.

TROUBLESHOOTING

Refer to troubleshooting chart in "B" and "BC" section, preceding.

NOTE: Refer to "Specifications" Section 8 for current specifications.

REMOVAL

1. Remove flame arrestor.
2. Disconnect fuel line and choke heat tube.
3. Disconnect throttle rod at carburetor and remove throttle return spring.
4. Remove 4 nuts and washers which attach carburetor to manifold.
5. Lift carburetor off manifold.
6. Remove and discard carburetor to manifold gasket.

DISASSEMBLY

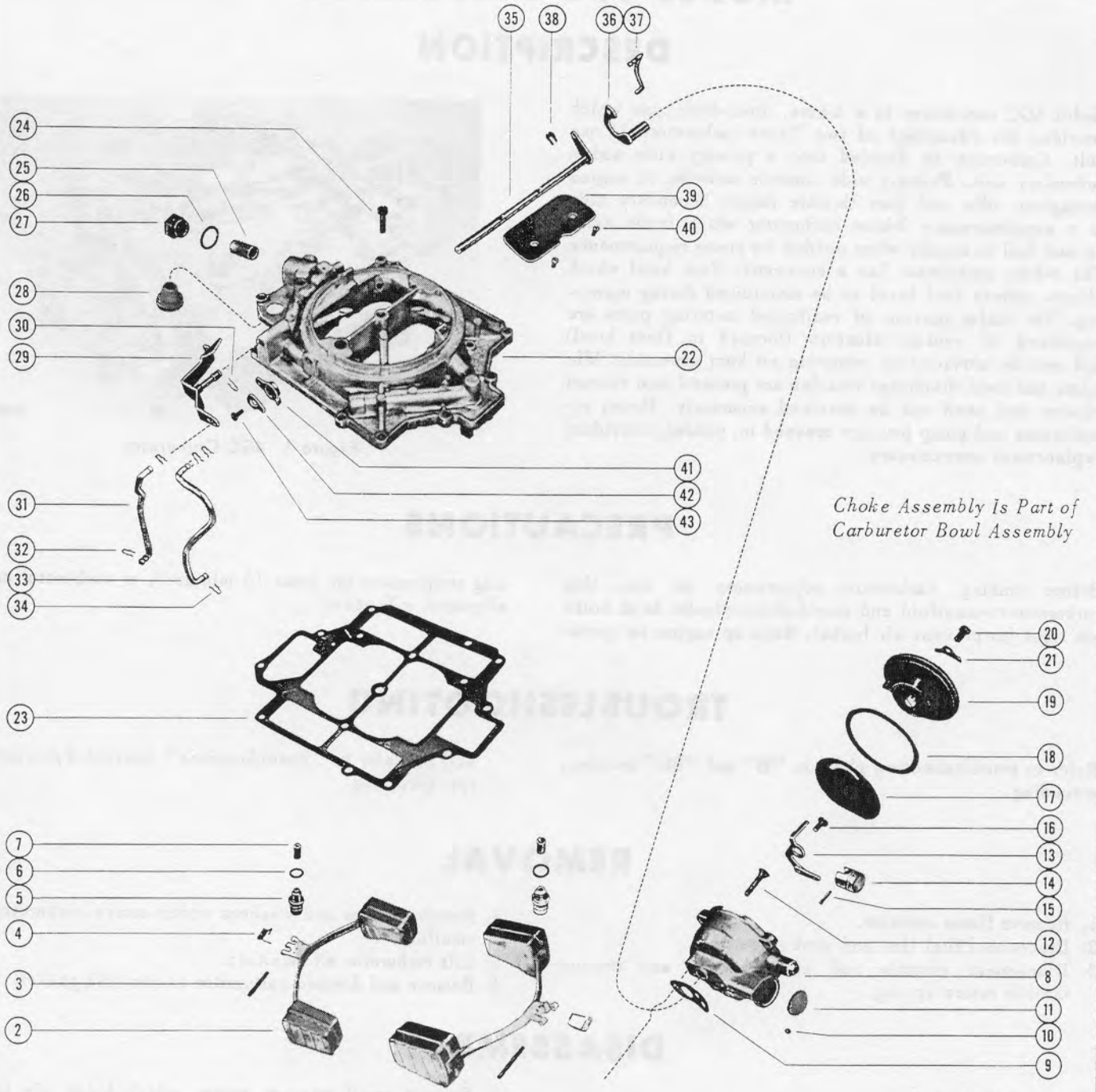
CHOKE ASSEMBLY

1. Mount carburetor on suitable holding fixture.
2. Disconnect intermediate choke rod at upper end.
3. Remove 3 choke cover attaching screws and retainers, then remove choke cover, gasket and coil assembly from carburetor. (Figure 4)
4. Carefully lift baffle plate from choke housing.
5. Remove choke housing attaching screws and remove choke housing from bowl.
6. Remove screw, which secures choke linkage to choke shaft, then remove piston, linkage and shaft.

BOWL COVER

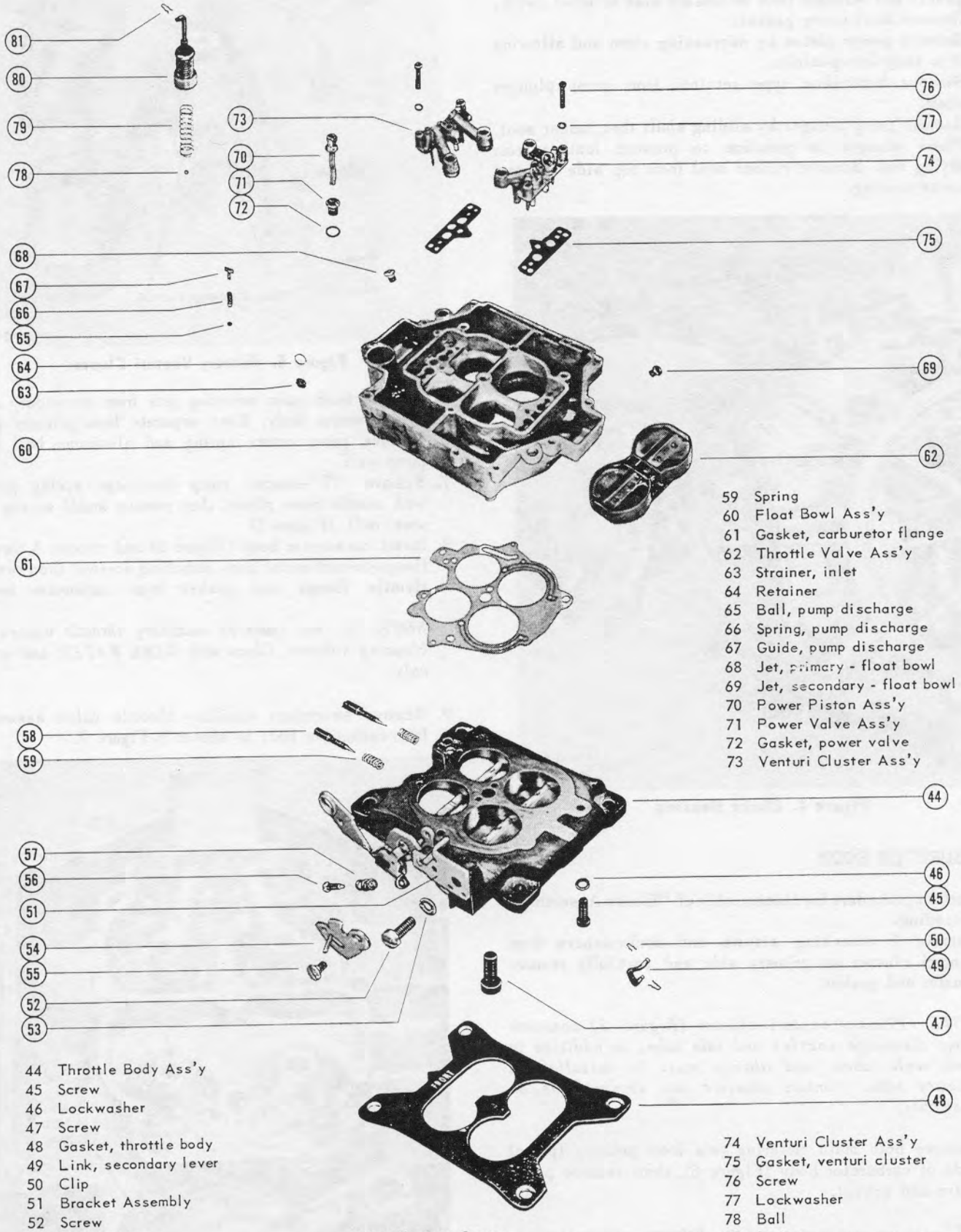
1. Remove gasoline inlet fitting and inlet screen.
2. Unhook spring clip from upper end of pump rod and remove rod and clip from pump lever.
3. Remove small retainer screw, which holds trip lever to choke shaft, then remove trip lever.
4. Remove 2 choke valve retaining screws and slide choke valve from shaft. Discard retaining screws.
5. Remove 13 bowl cover-to-carburetor body attaching screws.
6. Carefully lift bowl cover straight up until float is clear of carburetor body.
7. Invert bowl cover and remove hinge pin and spring from primary float, then lift float and needle from air horn. Mark float assembly "primary" to prevent unnecessary bending during assembly.
8. Remove primary float needle seat with a wide blade screwdriver. Remove seat gasket and strainer.

NOTE: Float needle and seat are factory-matched and must be installed in mated pairs. Never mix float needle and seats during cleaning or replacement.



2 Float Assembly
3 Pin, hinge - float to air horn
4 Spring, torsion - float
5 Inlet Needle and Seat Ass'y
6 Gasket, inlet needle and seat
7 Strainer, inlet needle and seat
8 Choke Housing Assembly
9 Gasket, choke housing
10 Plug, ball - choke housing
11 Welch Plug, choke housing
12 Screw
13 Lever Ass'y, choke piston
14 Choke Piston, choke housing
15 Pin
16 Screw
17 Plate, baffle - choke housing
18 Gasket, stat cover and coil
19 Stat Cover and Coil Ass'y
20 Screw
21 Retainer
22 Air Horn Assembly
23 Gasket, air horn
24 Screw, air horn to float bowl
25 Filter, air horn nut
26 Gasket, air horn filter nut
27 Nut, filter - air horn
28 Boot, float bowl pump
29 Pump Shaft and Lever Ass'y
30 Clip, pump shaft and lever
31 Rod, pump
32 Clip, retainer - pump rod
33 Rod, choke
34 Pin, hair - choke rod
35 Choke Shaft Assembly
36 Choke Shaft Assembly, intermediate
37 Rod, choke shaft
38 Clip, choke shaft rod
39 Valve, choke - choke shaft
40 Screw
41 Choke Lever and Collar Ass'y
42 Lever, trip - choke shaft
43 Screw, trip lever to choke shaft

Figure 2. Basic Carburetor Bowl Cover Exploded View



59 Spring
60 Float Bowl Ass'y
61 Gasket, carburetor flange
62 Throttle Valve Ass'y
63 Strainer, inlet
64 Retainer
65 Ball, pump discharge
66 Spring, pump discharge
67 Guide, pump discharge
68 Jet, primary - float bowl
69 Jet, secondary - float bowl
70 Power Piston Ass'y
71 Power Valve Ass'y
72 Gasket, power valve
73 Venturi Cluster Ass'y

44 Throttle Body Ass'y
45 Screw
46 Lockwasher
47 Screw
48 Gasket, throttle body
49 Link, secondary lever
50 Clip
51 Bracket Assembly
52 Screw
53 Lockwasher
54 Cam, fast idle
55 Screw

56 Idle Stop Screw
57 Spring, idle stop screw
58 Idle Adjusting Needle

74 Venturi Cluster Ass'y
75 Gasket, venturi cluster
76 Screw
77 Lockwasher
78 Ball
79 Spring
80 Pump Ass'y, float bowl
81 Pin, hair - float bowl pump

Figure 3. Basic Bowl Components Exploded View

9. Remove hinge pin and spring, float, needle seat, gasket and strainer from secondary side of bowl cover. Remove bowl cover gasket.
10. Remove power piston by depressing stem and allowing it to snap into position.
11. Remove horseshoe type retainer from pump plunger shaft.
12. Remove pump plunger by sliding shaft thru rubber seal. Place plunger in gasoline to prevent leather from drying out. Remove rubber seal from top side of bowl cover casting.

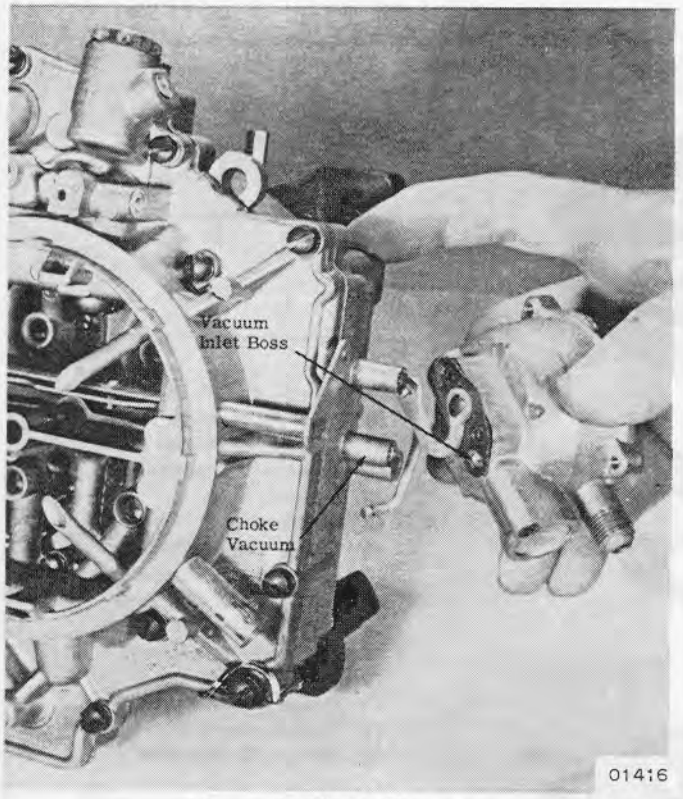


Figure 4. Choke Housing

CARBURETOR BODY

1. Perform procedure for disassembly of "Choke Assembly", preceding.
2. Remove 3 attaching screws and lockwashers from venturi cluster on primary side and carefully remove cluster and gasket.

NOTE: Primary venturi cluster (Figure 5) contains pump discharge nozzles and idle tube, in addition to main well tubes, and always must be installed on primary side. Venturi clusters are serviced as an assembly.

3. Remove both main metering jets from primary (pump) side of carburetor body (Figure 6), then remove power valve and gasket.

NOTE: Do not mix metering jets. Primary main metering jets are different from secondary side.

4. Remove 3 attaching screws and lockwashers from venturi cluster on secondary side and carefully remove cluster and gasket.

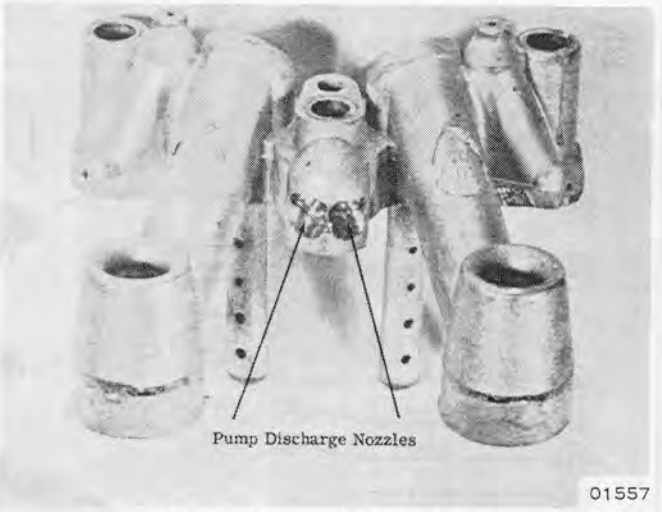


Figure 5. Primary Venturi Cluster

5. Remove both main metering jets from secondary side of carburetor body. Keep separate from primary jets.
6. Remove pump return spring and aluminum ball from pump well.
7. Remove "T"-shaped pump discharge spring guide with needle nose pliers, then remove small spring and steel ball. (Figure 7)
8. Invert carburetor body (Figure 8) and remove 4 throttle flange-to-carburetor body attaching screws, then remove throttle flange and gasket from carburetor body.

NOTE: Do not immerse auxiliary throttle valves in cleaning solvent. Clean with WARM WATER and brush only.

9. Remove secondary auxiliary throttle valve assembly from carburetor body as shown in Figure 9.

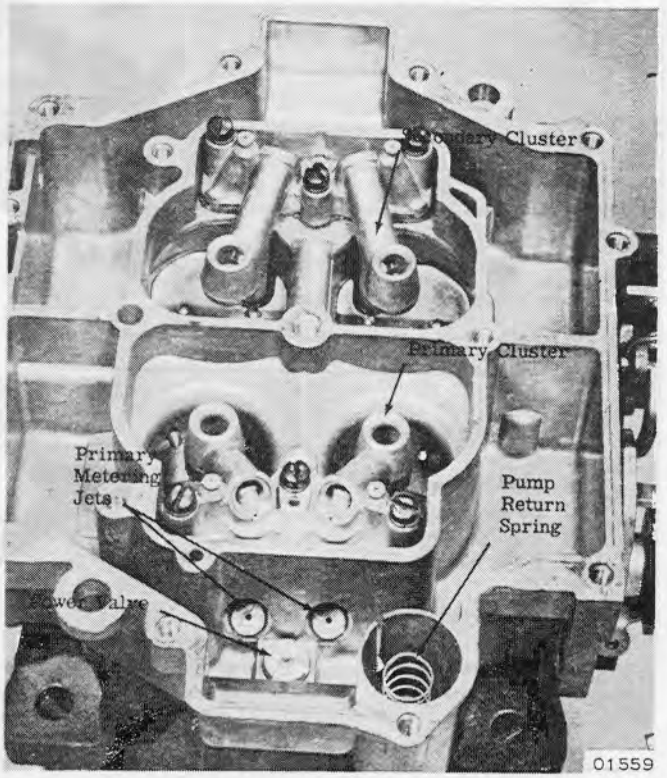


Figure 6. Bowl Parts Location

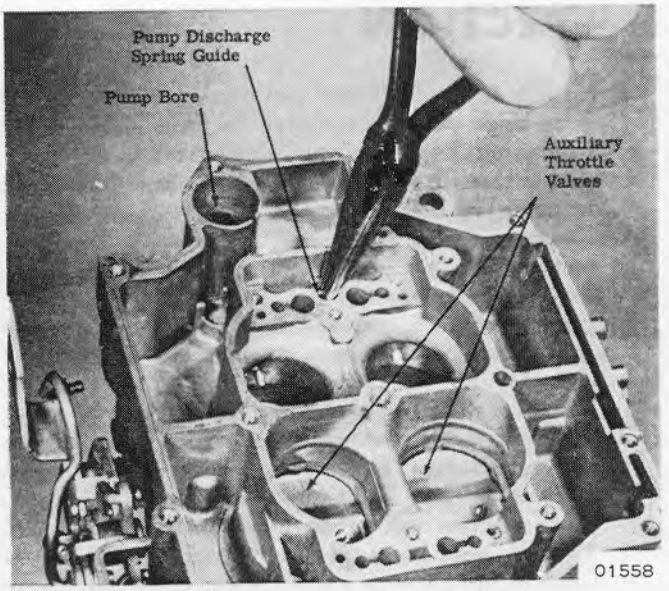


Figure 7. Removing Spring Guide

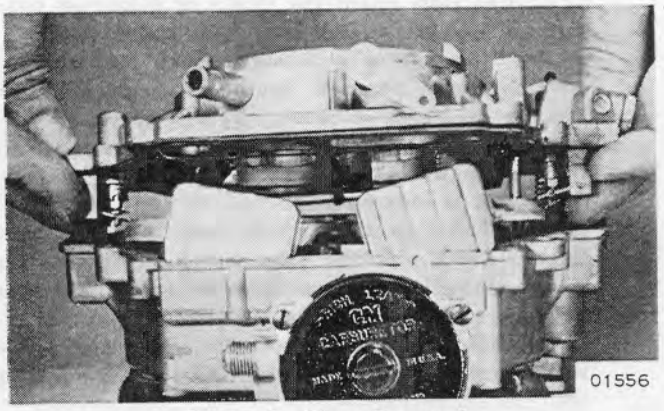


Figure 8. Float Removal

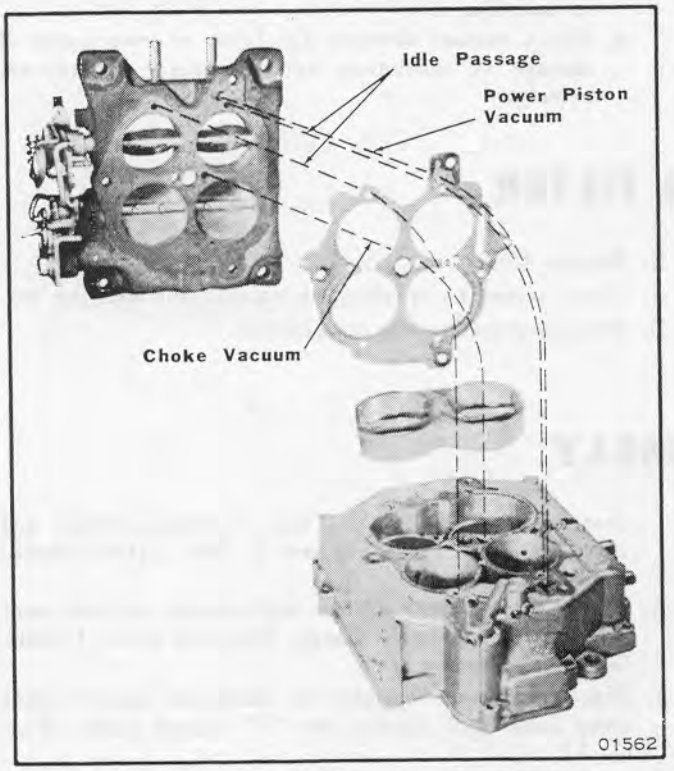


Figure 9. Passage Identification (Body Flange)

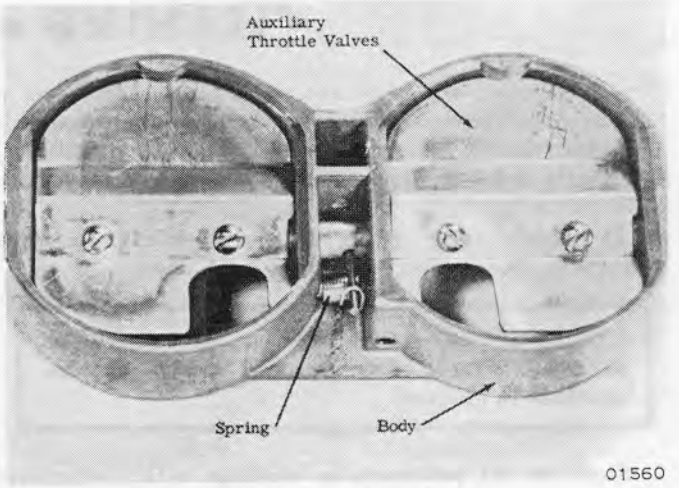


Figure 10. Auxiliary Valves

NOTE: Do not attempt further disassembly of auxiliary throttle valve assembly. (Figure 10) Spring tension is exactly calibrated, and any change will completely upset secondary side of carburetion operation, primarily during wide-open throttle.

10. Idle mixture needle screws may be removed for cleaning or replacement. Replace idle speed screw and spring, if necessary.

NOTE: Throttle flange and levers are serviced as a unit. No further disassembly of throttle flange should be attempted, as it may be impossible to again reassemble throttle valves correctly in relation to vacuum and idle discharge orifices.

THROTTLE FLANGE

Other than removal of idle mixture screws, idle speed screw and their springs (Figure 11), no disassembly of throttle flange is necessary or should be attempted. Only these screws and their springs are serviced as replacement parts; remainder of throttle flange is serviced as a unit.

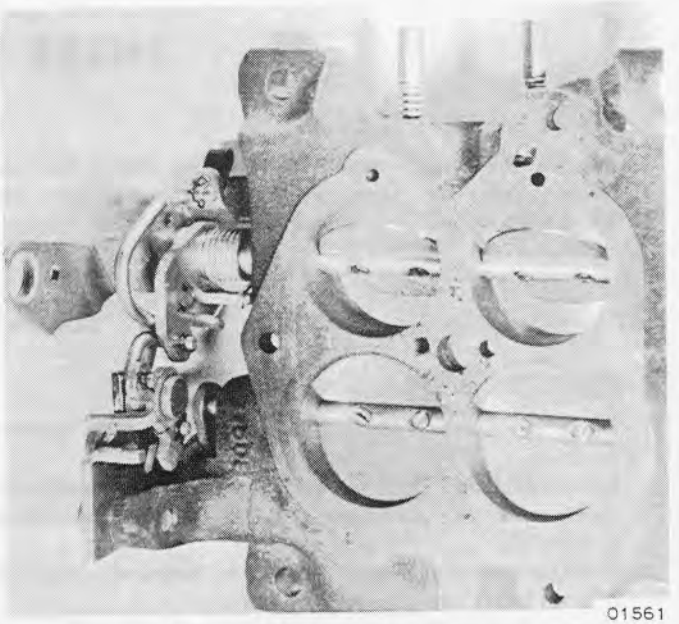


Figure 11. Throttle Flange

CLEANING and INSPECTION

Dirt, gum, water or carbon contamination in carburetor or on exterior moving parts of a carburetor often are responsible for unsatisfactory performance. For this reason, efficient carburetion depends upon careful cleaning and inspection while servicing.

1. Thoroughly clean carburetor castings and all metal parts in clean carburetor cleaning solution.

> **CAUTION: Composition and plastic parts (such as pump plunger and gaskets) should not be immersed in cleaner.**

2. Blow out all passages in castings with compressed air and blow off all parts so that they are free of cleaner (be sure to follow instructions furnished with cleaning solution).

   IMPORTANT: Do not use drills or wire to clean out jets or passages, as this may enlarge orifices and seriously affect carburetor calibration.

3. Carefully inspect parts for wear and replace those which are worn. Check following specific points:
   a. Inspect choke piston and choke piston housing for carbon. If necessary to clean choke piston housing, remove welch plug in top of housing. Remove plug by piercing center with a small instrument and prying out. Exercise care so that casting will not be damaged when removing plug. Before installing new plug, remove carbon from piston cylinder slots. Carefully clean welch plug seat. See "Automatic Choke" under "Adjustments on the Engine", following.
   b. Remove carbon from throttle flange cores with sandpaper. (Never use emery cloth.)
   c. Inspect float needles and seats for wear. If worn, replace both needle and seat.
   d. Inspect float pins for excessive wear.
   e. Inspect floats for dents and excessive wear on lip or at hinge pin holes. Check for fluid inside floats by shaking. Replace float, if defective.
   f. Inspect throttle shafts for excessive wear (looseness or rattle in body flange casting). Replace flange assembly if worn excessively.
   g. Inspect idle mixture adjusting screws for burrs. Replace if burred.
   h. Inspect pump plunger assembly. If leather is not in good condition, replace plunger as a complete assembly.
   i. To check pump system: Pour ½" (12.7mm) of gasoline into carburetor bowl. Take pump plunger from can of gasoline or kerosene and slide into pump cylinder. Place discharge check ball into body. Raise plunger and press lightly on shaft to expel air from pump passage. Hold discharge ball down firmly on its seat with a small, clean brass rod. Again raise plunger and press downward. No fuel should be emitted from either the intake or discharge passage. If any fuel is released from eigher passage, presence of dirt or a damaged check ball are indicated. Clean passage again and repeat test. If leakage still is present, replace check valve.
   j. Inspect upper and lower surfaces of carburetor body for damaged small sealing beads. Damaged beading may result in loss of air or fuel.
   k. Inspect holes in pump rocker arm, idle cam and throttle shaft lever. If holes are worn excessively or out-of-round and cause improper operation of carburetor, replace worn parts.
   l. Inspect idle cam for excessive wear. If excessive wear is noted, replace cam to assure proper warm-up and choking periods.
   m. Check all filters for lint or dirt. Clean or replace as necessary.
   n. Check venturi clusters for loose or worn parts. If damage or looseness exists, replace cluster assembly.

INLET FUEL FILTER

REMOVAL and REPLACEMENT

1. Remove fuel line connection at inlet fuel filter nut.
2. Remove inlet fuel filter nut from carburetor inlet fuel filter with a 3/4" box wrench or socket.
3. Remove filter.
4. Clean screen by washing in solvent and blowing out.
5. Reverse procedure for replacement.

REASSEMBLY

CARBURETOR BODY

1. Place carburetor body on holding stand in an inverted position.
2. Install auxiliary throttle valve assembly (with calibrated spring operating pin) down into base of carburetor body. (Figure 12)
3. Position throttle flange gasket on carburetor body so that all holes are properly aligned.
4. Place throttle flange on carburetor body and install 4 attaching screws (Figure 13), then tighten 3/8" x 24 center screw 9-to-10 ft. lbs. (1.24-to-1.38mkg) and 12 x 28 outer screws 3-to-4 ft. lbs. (.41-to-.55mkg) torque.
5. Install idle mixture screws and springs as they were removed from throttle flange. Back off screw 1½-turn for initial adjustment.
6. Place carburetor upright on stand and install steel pump outlet ball, spring and "T" shaped guide. (Figure 14)

   NOTE: Steel outlet ball is 3/16" (4.8mm) in diameter.

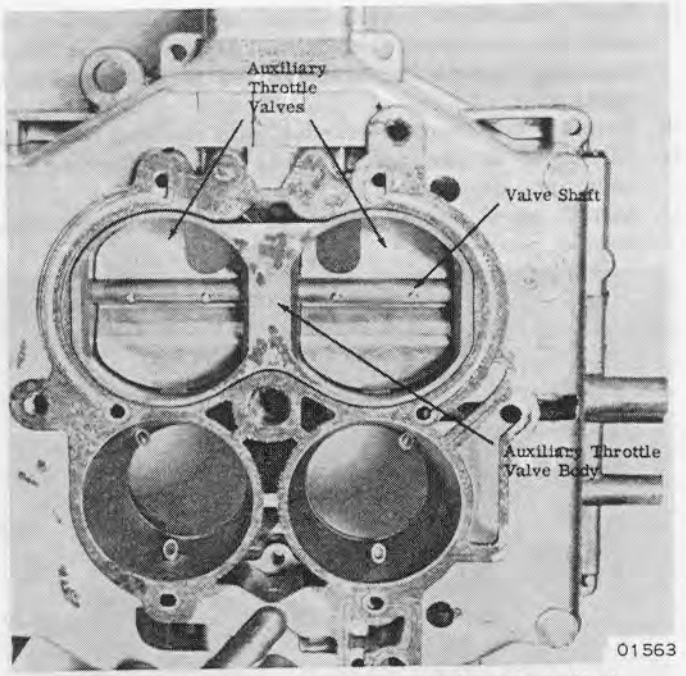


Figure 12. Auxiliary Throttle Valves Installed

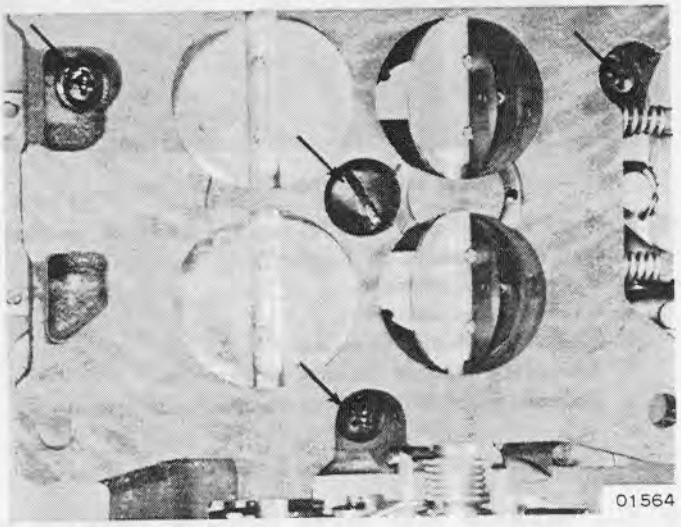


Figure 13. Throttle Flange Attaching Screws

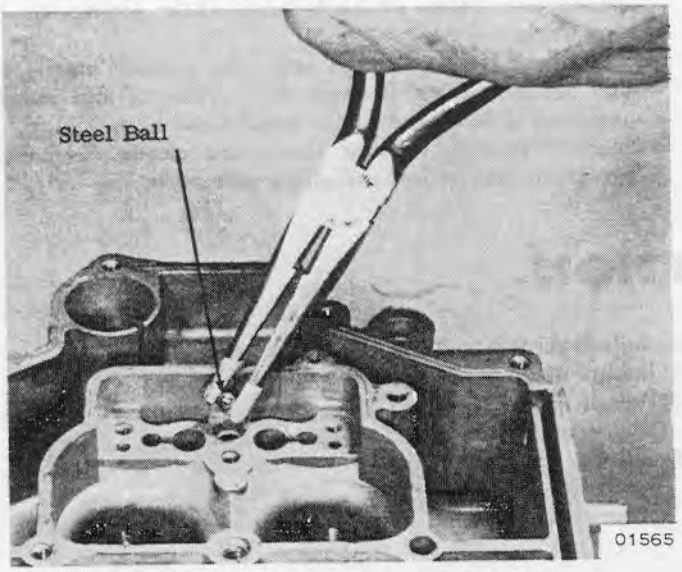


Figure 14. Installing Steel Ball

7. Install aluminum ball and pump return spring in pump plunger cylinder.

   NOTE: Spring must be all-the-way down and seated.

8. Replace pump inlet screen, if removed in disassembly.
9. Install 2 primary main metering jets and power valve.
10. Install 2 secondary main metering jets.
11. Install secondary venturi cluster and gasket with 3 attaching screws and lockwashers. (Secondary venturi does not carry pump discharge nozzles.) (Figure 5)
12. Install primary venturi cluster and gasket with 3 attaching screws and lockwashers.
13. Install choke assembly in reverse order of disassembly previously outlined.

BOWL COVER

1. Install power piston into bowl cover and stake very lightly to hold piston in place.
2. Assemble rubber seal on pump plunger shaft.
3. Position pump plunger with rubber seal in bowl cover by inserting small end thru from bottom. Lips of seal must be sealed on both sides of bowl cover.
4. Install needle seat gasket.
5. Install needle seat with wide-blade screwdriver. Repeat operation for other needle and seat.

   IMPORTANT: Install needle seats on same sides from which they were removed to match their respective float needle.

6. Install both float and needle and spring assemblies on bowl cover, retaining in place with hinge pin.

   NOTE: Float level and float drop adjustments are made independent of eachother and must be made at this stage of assembly procedure. All other adjustments are made after carburetor assembly has been completed. Float adjustments are outlined in this section under "Adjustments on Engine".

CARBURETOR REASSEMBLY

1. Carefully guide cowl cover assembly on carburetor body, positioning pump plunger into well and closely observing alignment of floats and power piston shaft.
2. Align bowl cover and gasket to holes in body and start 13 bowl cover attaching screws. (Figure 15)
3. Tighten 3 inner attaching screws evenly and securely, then tighten remaining outside screws in same manner.
4. Assemble choke housing and gasket to bowl and tighten with 2 countersunk head screws. (Figure 16)
5. Install choke shaft and piston assembly by sliding shaft thru its bore, then carefully fit piston in bore of housing and install lever attaching screw. (Figure 16)
6. Rotate choke shaft clockwise to check for free movement of shaft and piston. (Figure 16)
7. Install choke valve shaft carefully, then slide choke valve thru shaft so letters "RP" on valve face up with valve closed.
8. Start 2 small brass choke valve to shaft attaching screws. Do not tighten.
9. Position choke counterweight over choke shaft.
10. Position choke trip lever over end of choke shaft. Be sure that small tab of trip lever is above choke

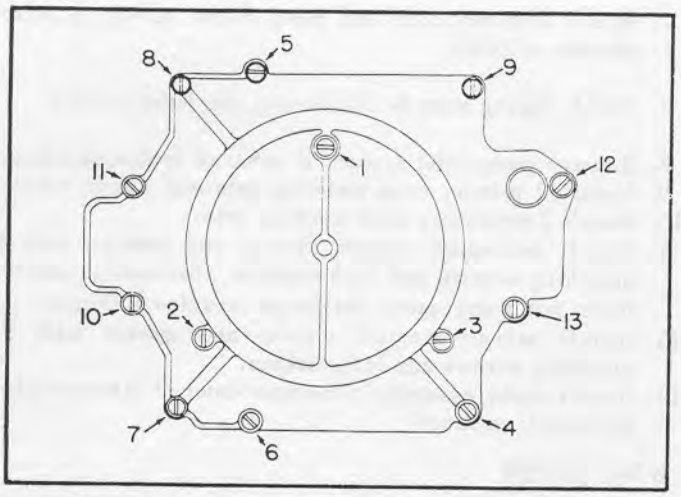


Figure 15. Air Horn Screw Tightening Sequence

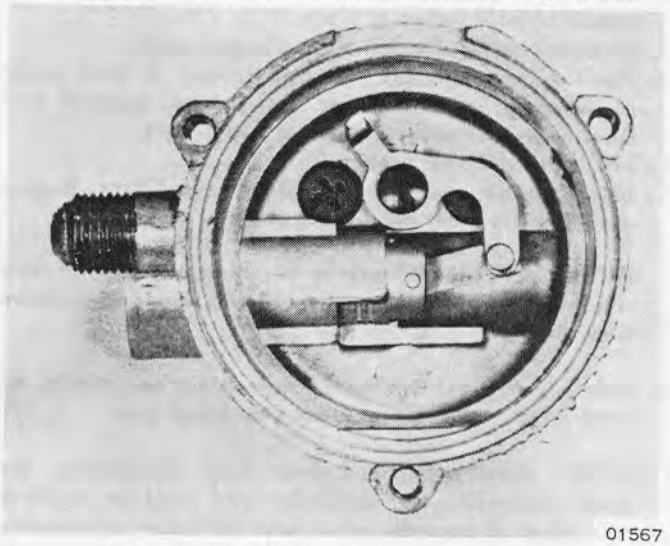


Figure 16. Choke Housing and Piston

counterweight tang and keyed to choke shaft before tightening retaining screw. (Figure 17)

11. To provide correct fit of choke valve in bowl cover, push lightly on end of choke shaft to obtain a minimum clearance of .020". Gauge between trip lever and choke counterweight as shown in Figure 17.
12. While holding choke shaft in this position, tighten choke valve retaining screws. Check for free operation of choke valve in air horn.
13. Connect intermediate choke rod to choke valve shaft lever, then place baffle plate in position in choke housing.
14. Install thermostat cover and coil assembly. gasket and retaining screws(with retainers). Leave housing cover retaining screws loose enough to permit rotation of cover.
15. Rotate cover counterclockwise until coil engages tang.
16. Set cover at one notch "Lean" mark. Tighten coil cover retaining screws.
17. Install upper end of pump rod (with spring retaining clip) on pump lever.

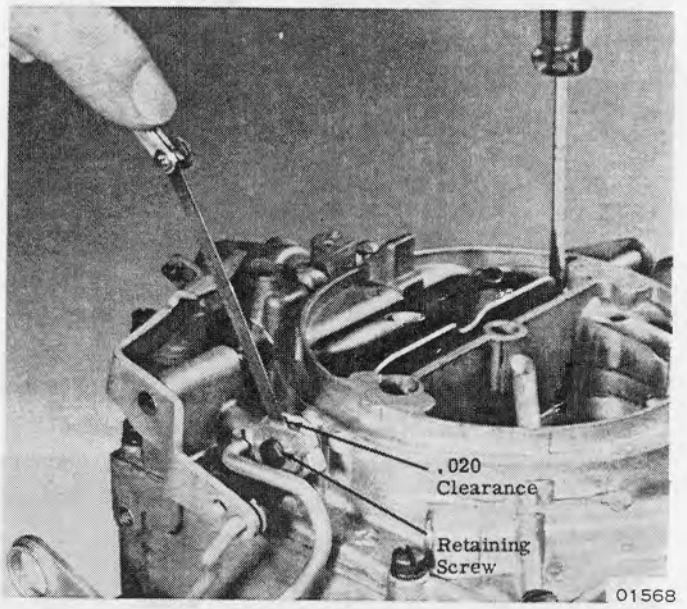


Figure 17. Spacing Choke Valve

18. Perform operations in following sequence as outlined under "Adjustments on Engine".
    a. Pump rod adjustment.
    b. Choke rod adjustment.
    c. Choke unloader adjustment.
    d. Secondary throttle locknut adjustment.
    e. Secondary throttle contour-clearance adjustment.

TEST before INSTALLATION on ENGINE

1. Fill carburetor bowl before installing carburetor to reduce strain on starting motor and battery and to reduce possibility of back-firing while attempting to start engine.
2. Clamp fuel pump to bench and, with a small supply of fuel and necessary fittings, fill carburetor and check operation of float and intake needle and seat.
3. Operate throttle several times and check discharge from pump jets before installing carburetor.

INSTALLATION

1. Throttle flange body and intake manifold gasket surfaces must be clean.
2. Install new gasket and carburetor.
3. Install 4 nuts and tighten evenly.
4. Install choke heat tube and fuel line.
5. Install throttle rod and return spring.
6. Install flame arrestor.
7. Adjust idle speed and mixture as outlined in "Adjustments on Engine", following.
8. Adjust secondary throttle valve lock spring as described in "Adjustments", following.

ADJUSTMENTS on ENGINE

Complete following adjustments without removing carburetor from engine and in following sequence:

1. Idle speed and mixture adjustment.
2. Float level and drop adjustment.
3. Pump rod adjustment.
4. Automatic choke adjustment.
5. Choke rod adjustment.
6. Choke unloader adjustment.
7. Secondary throttle lockout adjustment.
8. Secondary throttle contour-clearance adjustment.

NOTE: No adjustment of fast idle speed is provided.

IDLE SPEED and MIXTURE ADJUSTMENTS

NOTE: Always make idle mixture adjustment with flame arrestor installed.

1. Connect tachometer to engine.
2. With a thoroughly warmed-up engine, check that choke is fully off (open) and carburetor is on slow idle.
3. Start engine and allow to idle. Adjust idle speed screw to 500 RPM.
4. Adjust each idle mixture screw separately to give peak RPM indications on tachometer.

NOTE: Approximate mixture adjustment can be accomplished by setting idle mixture screws lean to a moderate-rough idle, which will give a slight speed loss, then back screws out (enrich) ¼-turn.

5. Shut off engine and remove tachometer.

FLOAT LEVEL and DROP ADJUSTMENTS

1. Remove bowl cover with gasket from carburetor as outlined under "Disassembly", preceding.
2. Invert air horn with gasket in place. Distance from gasket surface to top heels of primary floats is 1-3/8" (34.9mm). Distance from gasket surface to top heels of secondary floats is 1-11/32" (34.1mm). Bend float arm to adjust. (Figure 18)
3. With air horn still inverted and gasket in place, distance from gasket to center of dimple at primary float toe is 11/16" (17.5mm) (Figure 19) Distance from gasket to center of dimple at secondary float is 9/16" (14.3mm). Hold float arm and bend toe of float to adjust. (Figure 19) Recheck float head adjustment, if toe adjustment is necessary.
4. Hold air horn upright, and distance from gasket to center of dimples on both secondary and primary should be 1-3/8" (34.9mm). Bend float tang to adjust. (Figure 20)

NOTE: "D" or round pontoon type floats are measured to lowest point.

5. Center floats in cut-out sections of gasket, and sides of floats must be parallel with adjacent edges of gasket. Bend float arms to adjust. (Figure 21)
6. Install bowl cover as outlined in "Reassembly", preceding.

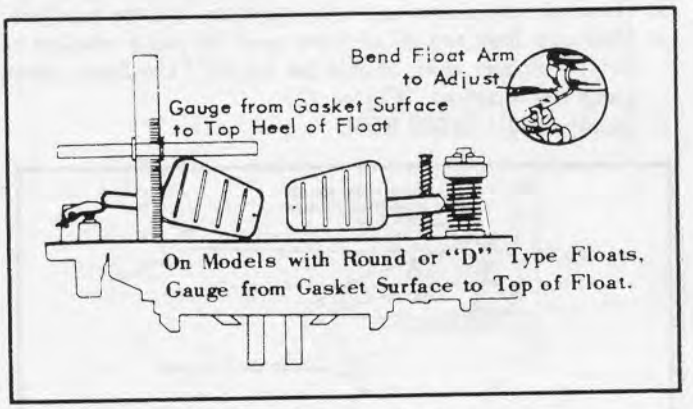


Figure 18. Float Level Adjustment

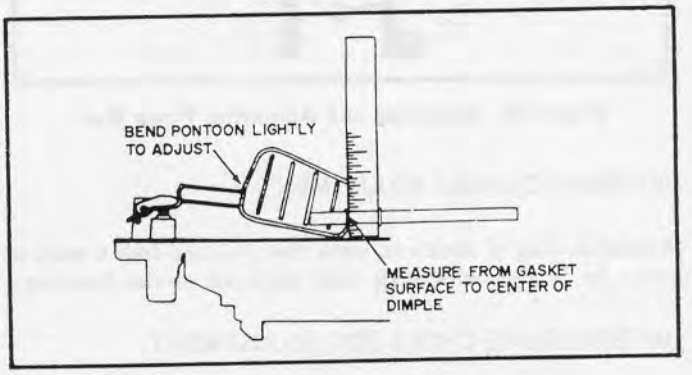


Figure 19. Float Toe Adjustment

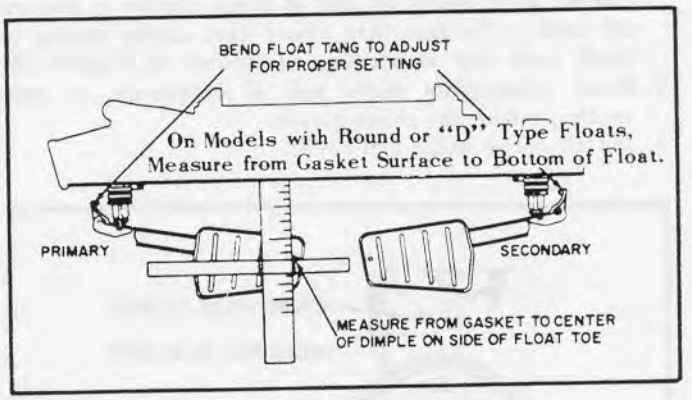


Figure 20. Float Drop Adjustment

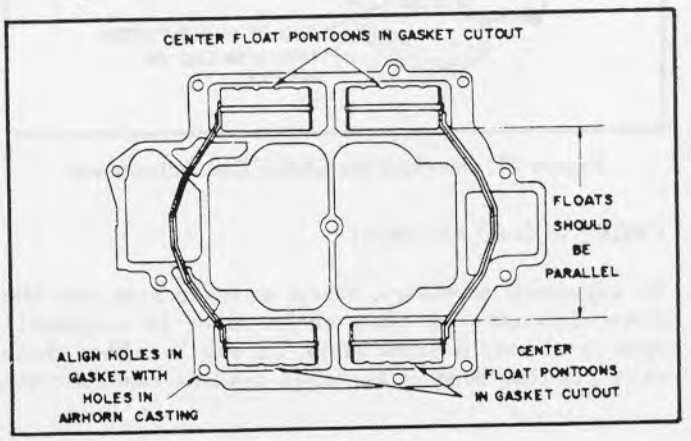


Figure 21. Float Adjustment

PUMP ROD ADJUSTMENT

1. Back off idle screw and allow primary valves to close.
2. Distance from top of air horn next to pump plunger to bottom plunger shaft should be 1-1/32" (26.2mm). Bend pump rod to adjust. (Figure 22)
3. Readjust idle to 500 RPM.

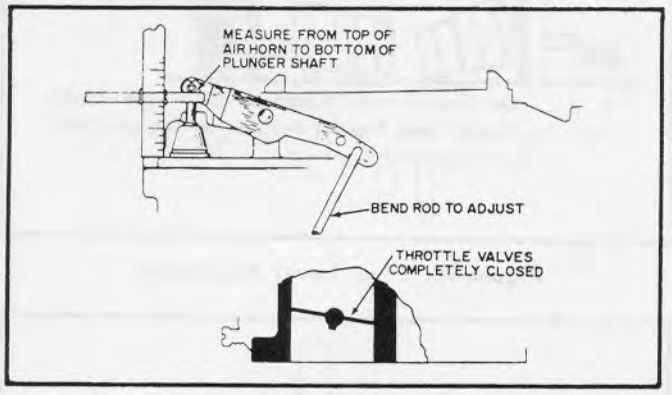


Figure 22. Checking and Adjusting Pump Rod

AUTOMATIC CHOKE ADJUSTMENT

Normal setting of choke is such that scribed index mark on cover is in line with long cast mark on choke housing.

INTERMEDIATE CHOKE ROD ADJUSTMENT

1. With choke cover and baffle removed, hold choke valve closed, push lightly on end of choke piston to remove all lash in linkage, then check that choke piston is flush with end of sleeve, as shown in Figure 23.
2. Bend intermediate choke rod, if necessary, to correctly position the choke piston.
3. Install choke baffle and cover.

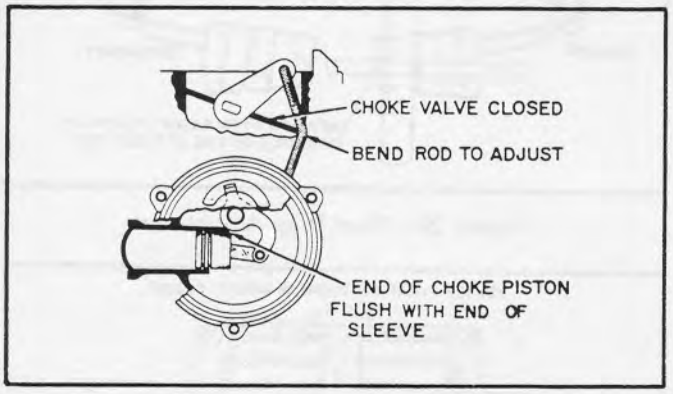


Figure 23. Intermediate Choke Rod Adjustment

CHOKE ROD ADJUSTMENT

No adjustment necessary, except to make sure that idle screw contacts cam when choke valve is completely open or closed. If screw drops off cam in either choke valve position, bend choke rod to position cam correctly.

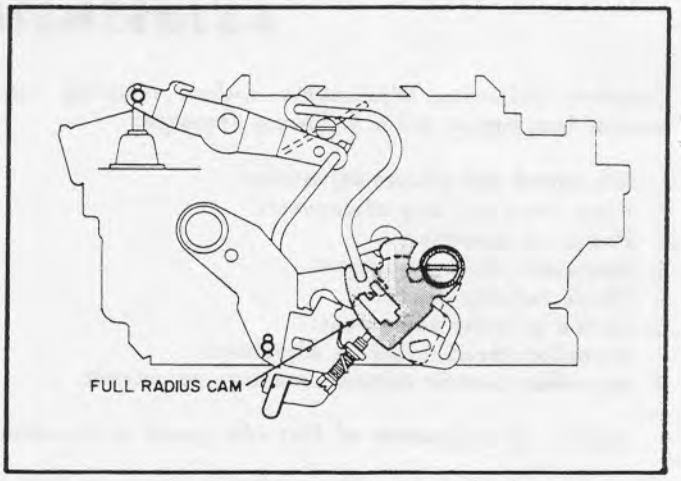


Figure 24. Choke Rod Adjustment

CHOKE UNLOADER ADJUSTMENT

1. With choke trip lever contacting choke counterweight lever, hold throttle valve in wide open position.
2. There should be a clearance of .120" (3.05mm) between top of choke valve and dividing wall of air horn. (Figure 25) Bend tang on fast idle cam to correct adjustment.

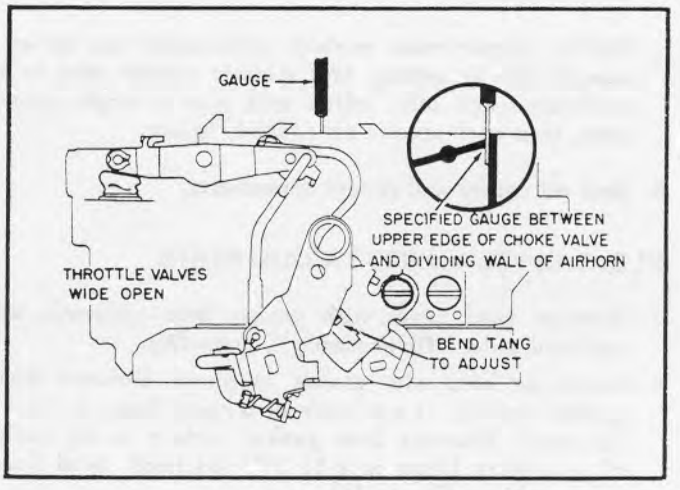


Figure 25. Choke Unloader Adjustment

SECONDARY THROTTLE LOCKOUT ADJUSTMENT

1. With choke valve closed so that secondary lockout tang is in fast idle cam slot, check clearance (.015" [.38mm]) between fast idle cam and tang. (Figure 26)
2. Bend tang horizontally.

SECONDARY THROTTLE CONTOUR CLEARANCE ADJUSTMENT

1. With choke valve held wide open and fast idle cam and secondary lockout lever positioned as shown in Figure 27, clearance between cam and tang should be .110" (2.8mm).
2. Bend tang vertically to adjust.

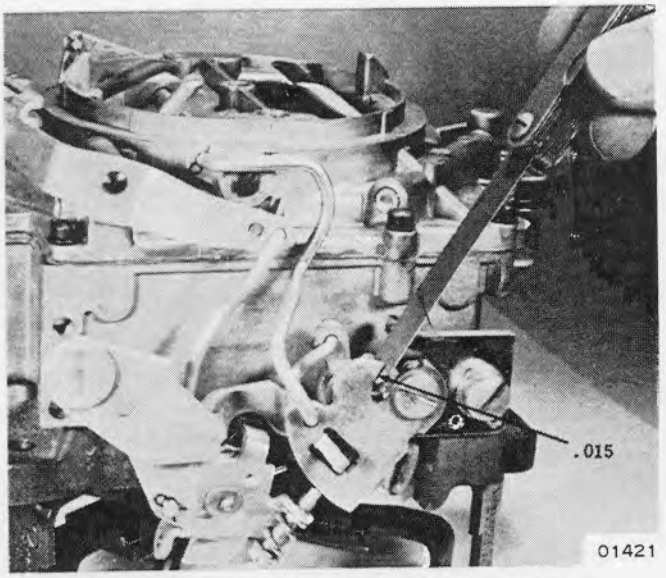


Figure 26. Secondary Lockout Adjustment

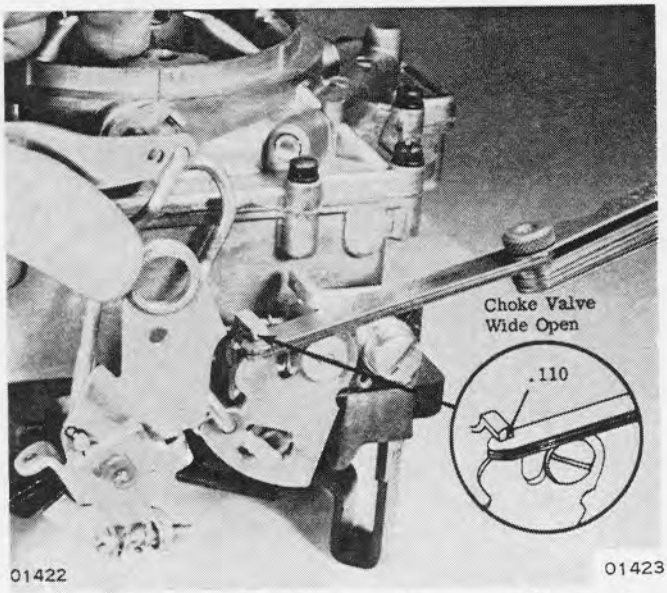


Figure 27. Secondary Contour Clearance Adjustment

SECONDARY THROTTLE VALVE LOCK SPRING ADJUSTMENT

Make this adjustment to ensure a positive closing of secondary throttle valves on "Idle". Adjustment of this U-shaped spring establishes tension against secondary operating lever, holding secondary throttle valves positively closed. (Figure 28) Following is adjustment procedure. This is an on-the-engine adjustment only.

1. Adjust carburetor idle speed and mixture (be sure secondary valves are completely closed). (Figure 29)
2. Shut off engine and place .050" feeler gauge between idle screw and idle cam as shown. (Figure 28)
3. Measure clearance (.025" [6.35mm]) between secondary lock spring and secondary throttle operating lever. Bend lock spring to adjust.

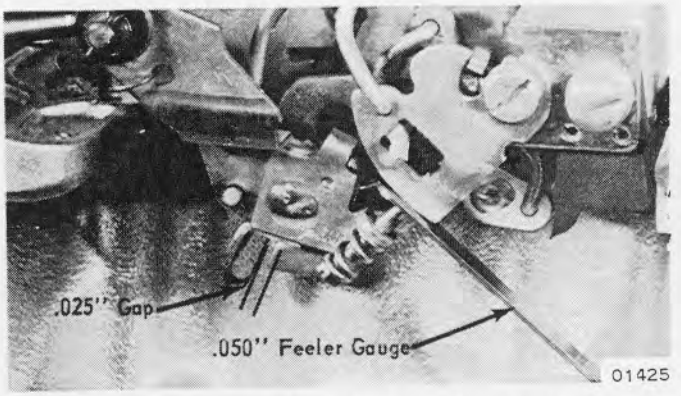


Figure 28. Secondary Throttle Lock Spring Adjustment

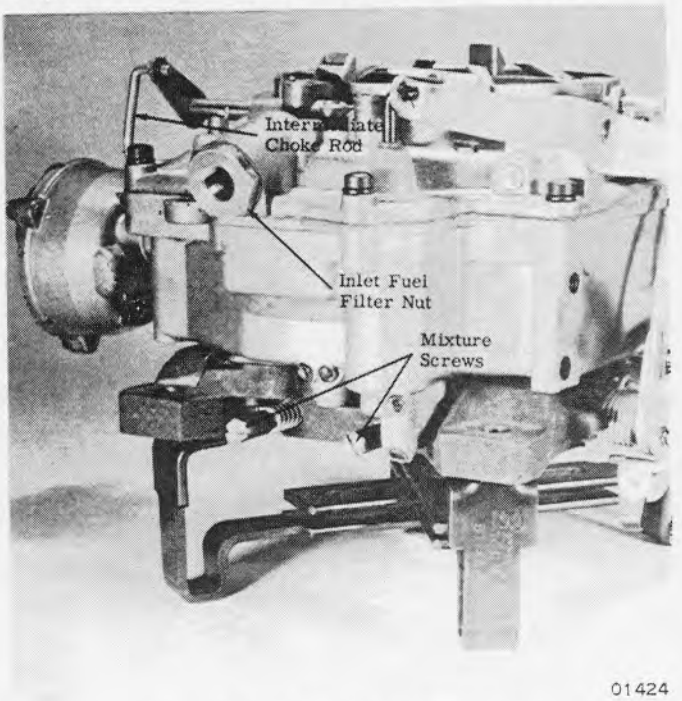


Figure 29. Idle Mixture Screws

HOLLEY MODEL 4160, 6407 and 6576 CARBURETORS

DESCRIPTION

Holley Models 4160, 6407 and 6576 are 4 venturi downdraft carburetors. The primary stage supplies fuel-air mixture throughout the entire range of operation, and the secondary stage operates when a greater quantity of fuel-air mixture is required. Both sides or stages of the carburetor contain a fuel bowl, fuel inlet valve, float and metering block.

In addition, the primary side includes the accelerator pump and air horn and choke system.

All venturis include a booster venturi and a main discharge nozzle built into the booster venturi.

The carburetor utilizes 4 metering systems: Idle system, main metering system, power enrichment system and accelerator pump system.

Also, there are float systems, a choke system and a secondary operation system.

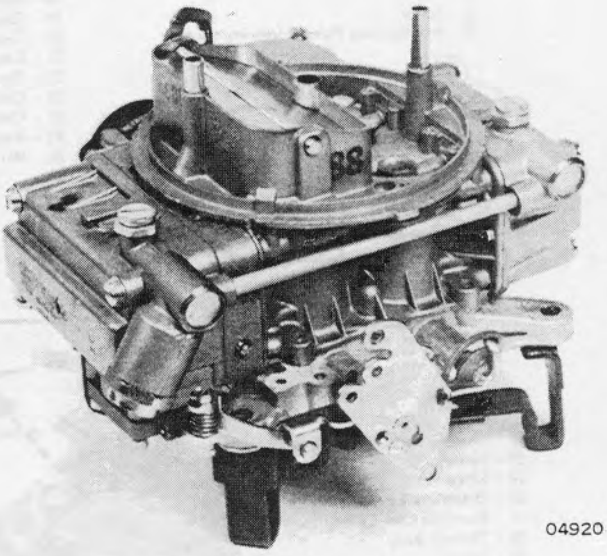


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Figure 1. Holley Carburetor

PRECAUTIONS

Before making carburetor adjustments, be sure that carburetor-to-manifold and manifold-to-cylinder head bolts are tight to prevent air leaks. Carburetor misadjustment will occur if engine is not warmed to operating temperature prior to making adjustments. Allow engine to run at least 15 minutes.

TROUBLESHOOTING

Refer to troubleshooting chart in "B" and "BC" section.

NOTE: Refer to "Specifications" section for current specifications.

REMOVAL

1. Remove flame arrestor assembly and mounting gasket. Disconnect fuel inlet hose from carburetor and discard retaining clamp. Use care to prevent fuel spillage that could cause a fire.
2. Remove 4 carburetor retaining nuts. Remove carburetor and mounting gasket.

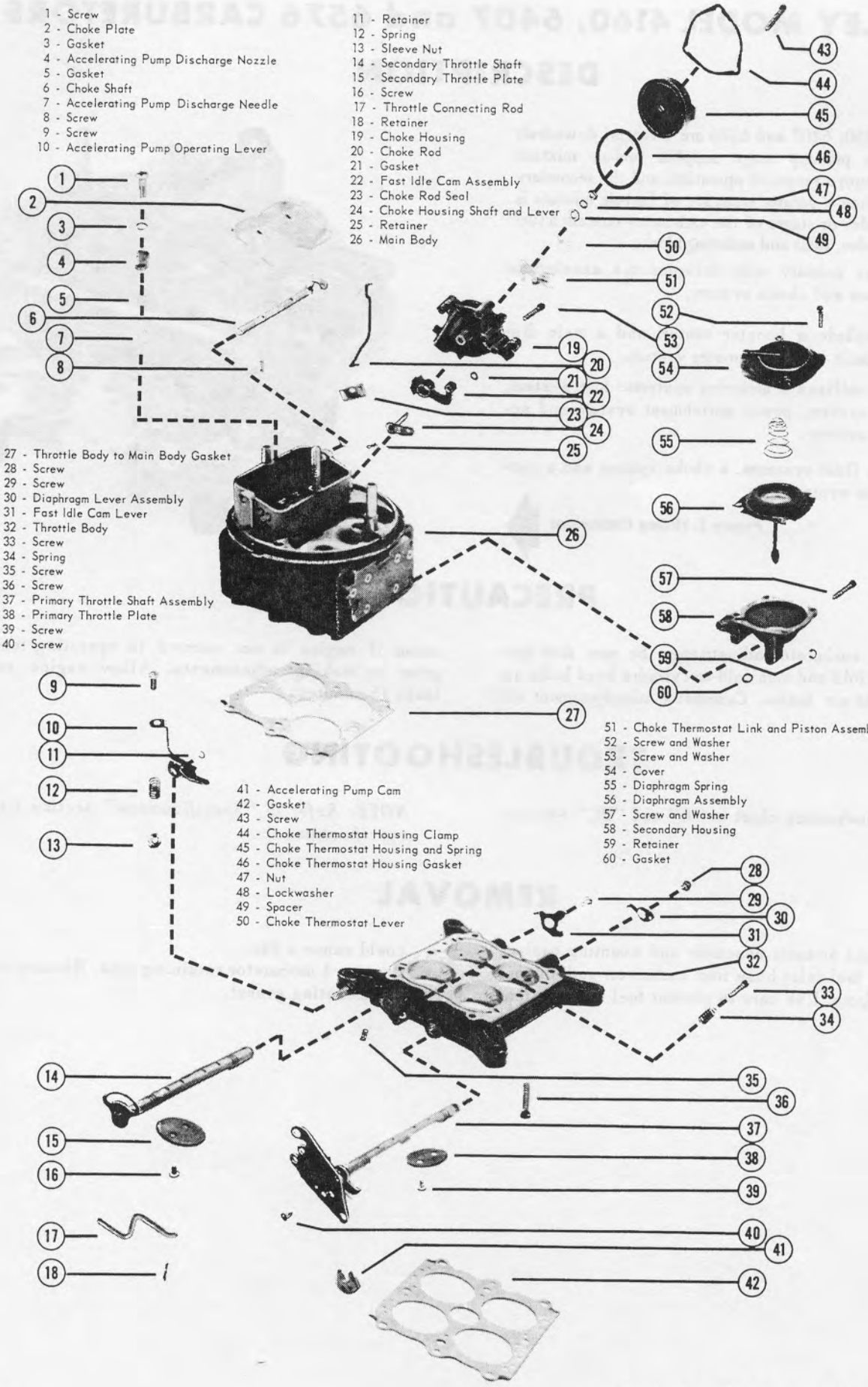

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Figure 2. Holley Carburetor Exploded View

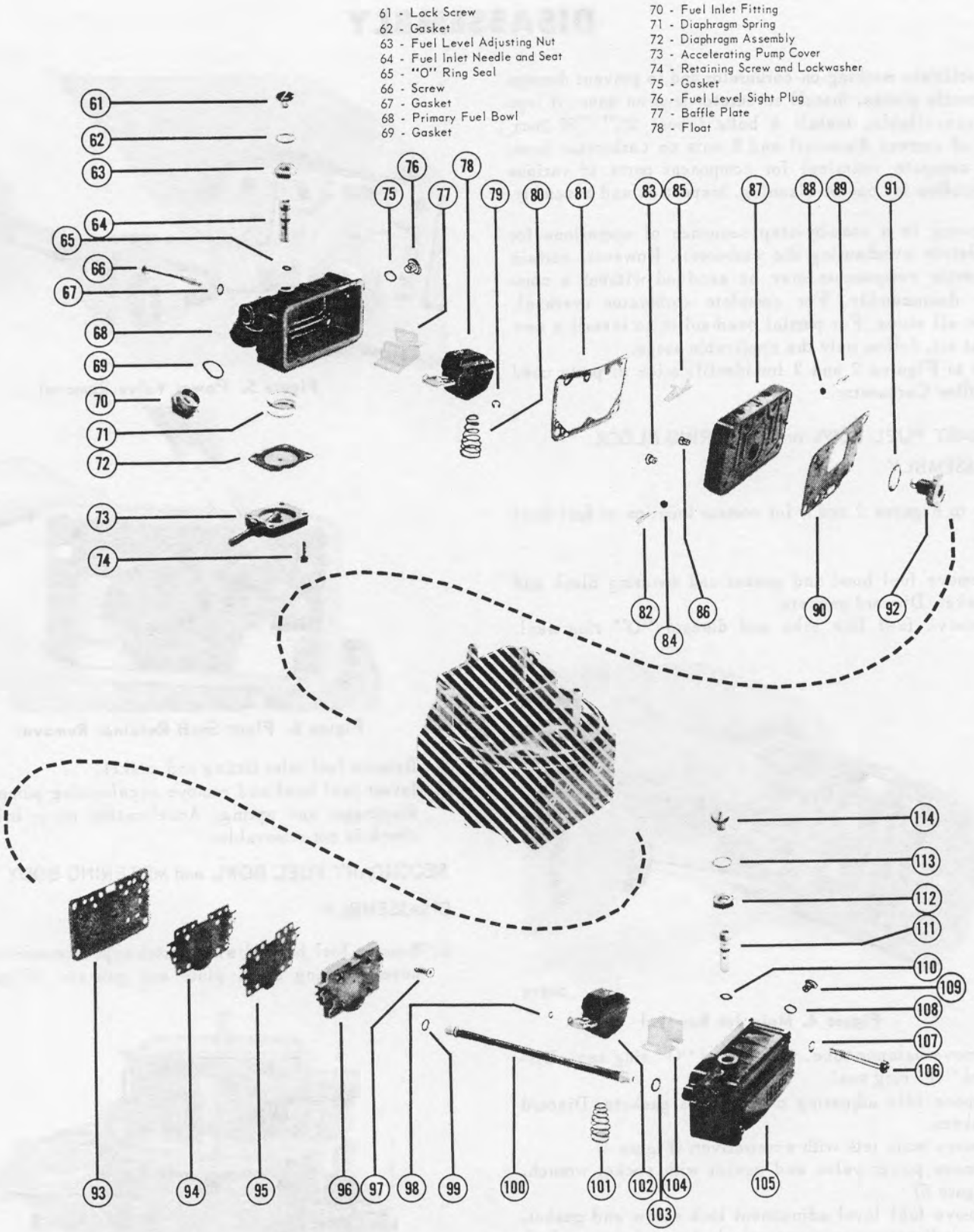

Figure 3. Holley Carburetor Exploded View

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DISASSEMBLY

To facilitate working on carburetor and to prevent damage to throttle plates, install carburetor legs on base. If legs are unavailable, install 4 bolts (about 2¼" [57.2mm] long of correct diameter) and 8 nuts on carburetor base. Use separate container for component parts of various assemblies for easier cleaning, inspection and assembly.

Following is a step-by-step sequence of operations for completely overhauling the carburetor. However, certain carburetor components may be serviced without a complete disassembly. For complete carburetor overhaul, follow all steps. For partial overhaul or to install a new gasket kit, follow only the applicable steps.
Refer to Figures 2 and 3 for identification of parts used on Holley Carburetor.

PRIMARY FUEL BOWL and METERING BLOCK DISASSEMBLY

Refer to Figures 2 and 3 for correct location of fuel bowl parts.

1. Remove fuel bowl and gasket and metering block and gasket. Discard gaskets.
2. Remove fuel line tube and discard "O" ring seal.

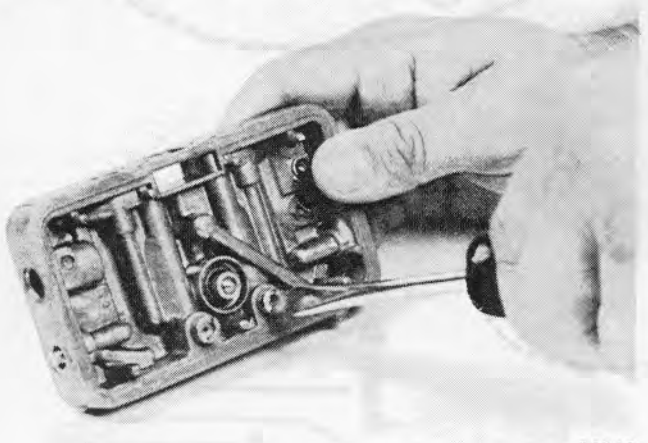

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Figure 4. Main Jet Removal

3. Remove balance tube, washer and "O" ring seal. Discard "O" ring seal.
4. Remove idle adjusting needles and gaskets. Discard gaskets.
5. Remove main jets with screwdriver. (Figure 4)
6. Remove power valve and gasket with socket wrench. (Figure 5)
7. Remove fuel level adjustment lock screw and gasket. Turn adjusting nut counterclockwise and remove lock nut and gasket. Remove fuel inlet needle and seat assembly. Do not disassemble fuel inlet needle and seat. They are matched assemblies and are replaced as an assembly.
8. Remove float retainer with needle-nose pliers. (Figure 6) slide float off shaft. Remove spring from float.
9. Remove baffle plate from fuel bowl.
10. Remove fuel level sight plug and gasket.

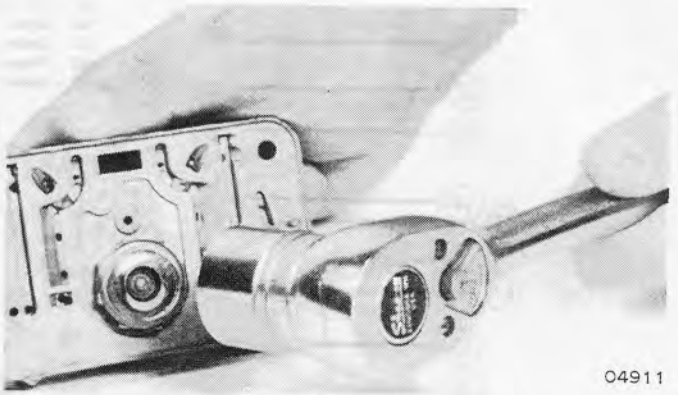

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Figure 5. Power Valve Removal

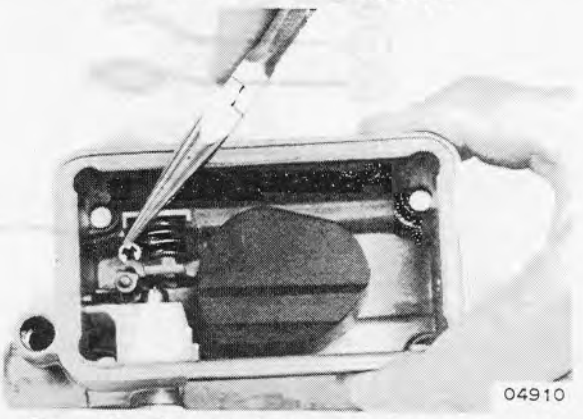

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Figure 6. Float Shaft Retainer Removal

11. Remove fuel inlet fitting and gasket.
12. Invert fuel bowl and remove accelerating pump cover, diaphragm and spring. Accelerating pump inlet ball check is not removable.

SECONDARY FUEL BOWL and METERING BODY DISASSEMBLY

1. Remove fuel bowl. Using clutch-type screwdriver, remove metering body, plate and gaskets. (Figure 7).

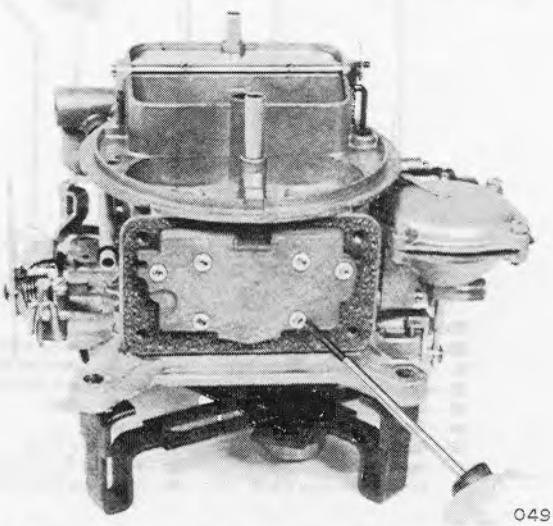

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Figure 7. Secondary Metering Body Removal

2. Disassemble fuel bowl by following Steps 7-thru-10 under "Primary Fuel Bowl and Metering Block Disassembly", immediately preceding.

MAIN BODY DISASSEMBLY

1. Remove flame arrestor anchor stud and secondary diaphragm link retainer.
2. Invert carburetor and remove throttle body retaining screws and lockwashers. Lift off throttle body and discard throttle body gasket.
3. Remove choke rod retainer from choke housing shaft and lever assembly. Remove thermostatic spring housing and gasket, then remove choke housing and gaskets from main body. Remove choke housing shaft nut, lockwasher and spacer, then remove shaft and fast idle cam. Remove choke piston and lever assembly. Remove choke rod and seal from main body. If necessary, remove choke plate from choke shaft and slide shaft and lever out of air horn. Retaining screws are staked to choke shaft. If tips of screws are flared excessively, file off flared portion to avoid damage to threads in choke shaft. Be careful not to damage choke shaft or venturi while filing screws.
4. Remove secondary diaprhagm housing and gasket from main body. Housing must be removed before cover can be removed. Remove diaphragm housing cover, then remove spring and diaphragm from housing.
5. Remove accelerating pump discharge nozzle screw and lift pump discharge nozzle and gaskets out of main body. Invert main body to allow accelerating pump discharge needle to drop out into hand.

THROTTLE BODY DISASSEMBLY

1. Remove accelerating pump operating lever retainer.
2. Remove secondary throttle connecting rod retainers and connecting rod. Remove secondary diaphragm lever and fast idle cam lever retaining screws and washers. Remove levers.
3. If necessary, remove throttle stop screw and spring.
4. If necessary to remove throttle plates, lightly scribe throttle plates along throttle shaft and mark each plate and its corresponding bore with a number or letter for proper installation. (Figure 8) Remove throttle plates. Retaining screws are staked to throttle shaft. If tips of screws are flared excessively, file off flared portion to avoid thread damage in throttle shaft. Be careful not to damage throttle shaft or venturi while filing screws.
5. Remove fast idle cam lever. Remove primary throttle shaft return spring from notch on throttle shaft lever. (Figure 2) Slide primary throttle lever and shaft assembly out of throttle body. Remove accelerating pump cam. Slide secondary throttle shaft out of main body.

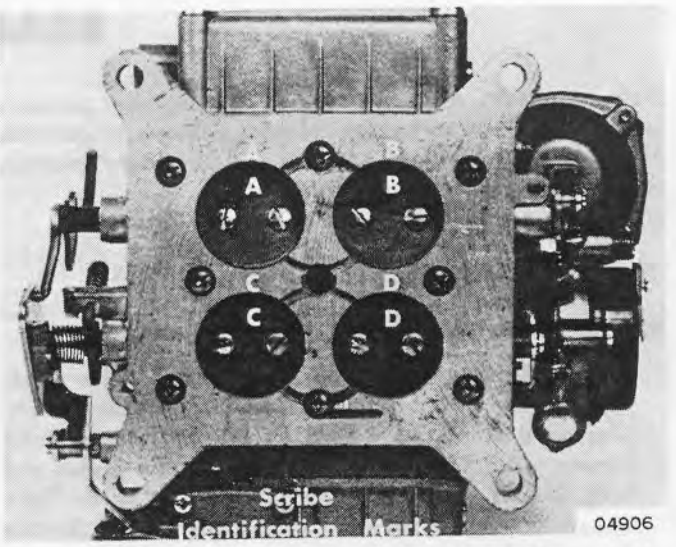


Figure 8. Throttle Plate Removal

CLEANING and INSPECTION

1. Clean carburetor in a cold immersion-type cleaner, such as Carbon-X (X-55) or its equivalent.

> **CAUTION: Any rubber parts, plastic parts, diaphragms and pump plungers should not be immersed in carburetor cleaner. Delrin cam on air valve shaft will withstand normal cleaning in carburetor cleaner.**

2. Blow out all passages in castings with compressed air. DO NOT pass drills thru jets or passages.
3. Inspect idle mixture needles for damage.
4. Examine inlet needle and seat for wear. If worn, replace with new inlet needle and seat assembly.
5. Inspect upper and lower surfaces of carburetor castings for damage.
6. Inspect holes in levers for excessive wear or out-of-round condition. If worn, replace levers.
7. Examine fast idle cam for wear or damage.
8. Check air valve for binding condition. If air valve is damaged, replace air horn assembly.
9. Check all throttle levers and valves for binds or other damage.

REASSEMBLY

Make sure that all holes in new gaskets are properly punched and that no foreign material adheres to gaskets. Be certain that accelerating pump and secondary operating diaphragms are not cut or torn.
Carburetor assembly is shown in Figures 2 and 3.

THROTTLE BODY REASSEMBLY

Refer to Figure 9 for correct location of parts.

1. If secondary throttle plates are removed, slide shaft into throttle body. Refer to lines scribed on throttle plates, then install plates in proper location with screws snug but not tight. Close throttle plates and hold throttle body up to the light. Little or no light should be visible between throttle plates and throttle bores. If throttle plates are properly installed and no binding exists when throttle shaft is rotated, tighten throttle plate screws. Stake screws by supporting shaft and plates on block of wood or soft metal bar to prevent shaft from bending.
   Refer to "Adjustments" for correct adjustment of secondary throttle plates.
2. Install secondary diaphram lever, lockwasher and screw.
3. If primary throttle plates were removed, place accelerating pump cam on primary throttle shaft. Place end of throttle connecting rod with smallest bend in position in primary throttle lever. Slide throttle shaft into throttle body, guiding throttle connecting rod so that other end fits into secondary throttle lever.

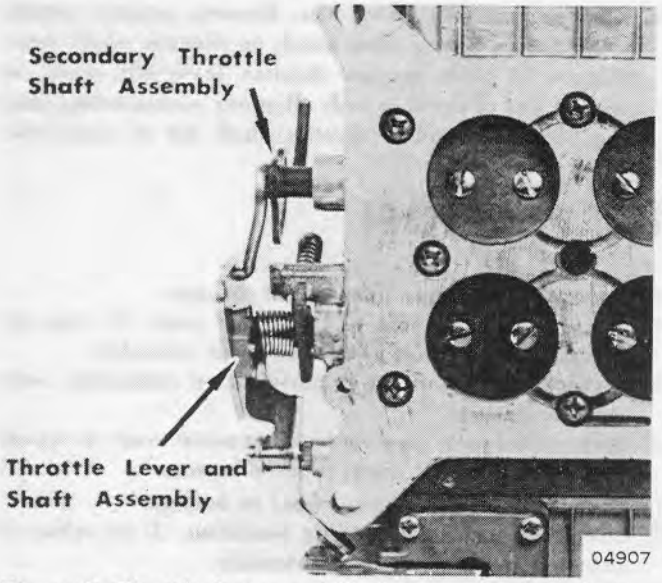


Figure 9. Throttle Lever and Shaft Assembly Installation

4. Position primary throttle return spring so that small tang fits into slot in throttle lever and long tang rests against throttle body stop. (Figure 9)
5. Secure end of connecting rod with pin retainer.
6. Install primary throttle plates with same procedures used for secondary throttle plates.
7. Install fast idle cam lever, lockwasher and screw.
8. Install throttle stop screw and spring.
9. Install accelerating pump operating lever and retainer.

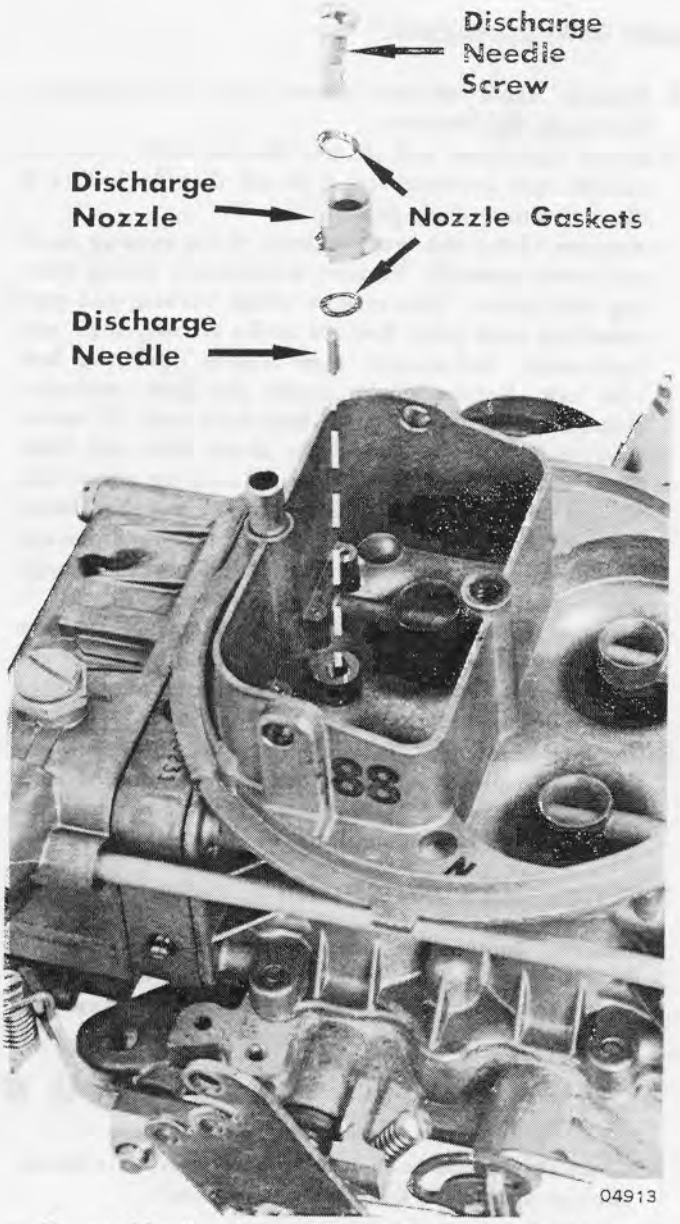


Figure 10. Accelerating Pump Discharge Assembly

MAIN BODY REASSEMBLY

1. Drop accelerator pump discharge needle into its well. (Figure 10) Lightly seat needle with brass drift and hammer. Position accelerating pump nozzle and gaskets in main body and install retaining screw.
2. Secondary diaphragm housing must be installed before choke housing. Position secondary diaphragm in housing and place spring in cover. (Figure 2) Install cover and tighten retaining screws finger-tight. Pull diaphragm rod downward to maximum travel and tighten cover screws. Diaphragm housing must be removed from main body to install cover.
3. Place gasket on secondary vacuum passage opening on main body. Place diaphragm housing in position on main body and install lockwashers and retaining screws.

4. Position choke plate shaft in air horn and install choke plate in shaft. (Figure 2) Install rod seal on choke rod. Slide U-shaped end of choke plate rod thru opening in main body and insert rod end thru inner side of bore in choke lever. Rod end must face outward. Push rod seal into retaining grooves on underside of flame arrestor mounting flange. Position choke thermostat lever link and piston assembly in choke housing. Position fast idle cam assembly on choke housing and install choke housing shaft and lever assembly. (Figure 2) Position lever and piston assembly on choke housing shaft and lever assembly. Install spacer, lockwasher and nut. Place main body assembly on its side and position choke housing gaskets on main body. Insert choke rod in choke housing shaft lever as choke housing is placed into position on main body. Be sure that projection on choke rod is placed under fast idle cam so that cam will be lifted when choke plate is closed. Install choke housing lockwashers and screws. Install choke rod cotter pin with needle-nose pliers.
   Place thermostatic spring housing gasket into position on choke housing (engaging thermostatic spring on spring lever), then install housing, clamp and screws. Adjust thermostatic spring housing by aligning index mark on cover with mid-position mark on choke housing.
5. Invert main body and position throttle body gasket on main body. Place throttle body on main body so that fuel inlet fitting will be on same side as accelerating pump operating lever. Slide secondary diaphragm rod onto operating lever as throttle body is placed into position Install throttle body to main body screws and lockwashers. Secure secondary diaphragm rod with retainer.
6. Install flame arrestor anchor stud.

PRIMARY FUEL BOWL and METERING BLOCK REASSEMBLY

Refer to Figures 2 and 3 for correct location of fuel bowl parts.

1. Place accelerating pump diaphragm spring and diaphragm in accelerating pump chamber. Diaphragm must be positioned so that large end of lever disc will be against operating lever. Install cover and tighten retaining screws finger-tight. Make sure diaphragm is centered, then compress diaphragm with pump operating lever and tighten cover screws.
   After carburetor is assembled, refer to "Adjustment" for correct adjustment of accelerating pump, following.
2. Install gasket and fuel inlet fitting.
3. Install fuel level sight plug and gasket.
4. Slide baffle plate onto ridges in fuel bowl.
5. Install float spring on float and slide float onto shaft. Be sure that float spring is between ridges on boss on floor of fuel bowl. Install float retainer with needle-nose pliers.
6. Apply petroleum jelly to new "O" ring seal and slide on fuel inlet needle and seat assembly.
7. Position fuel inlet needle and seat assembly in fuel bowl thru top of bowl. Position adjusting nut gasket and nut of fuel inlet needle and seat assembly. Align flat on ID of nut with flat on OD of fuel inlet needle and seat assembly. Install fuel level adjustment lock screw and gasket.
8. As a preliminary float adjustment, refer to "Adjustments", following, and perform "Float Level Adjustment (Dry)" procedure.
9. Install power valve and gasket in metering block with socket wrench. (Figure 5) Be sure to install correct power valve. Refer to specifications for correct identification number (stamped on flat on base of valve).
10. Install jets in metering block with screwdriver. (Figure 4)
11. Install idle adjusting needles and new gaskets. Turn idle adjusting needles in until they just touch the seat, then back needles off the specified number of turns for a preliminary idle adjustment.
12. Position metering block gasket on dowels (located on back of metering block). Position metering block and gasket on main body. Position baffle plate (primary side only) and gasket on metering block. Place retaining screws and new compression gaskets in fuel bowl. Position bowl in place on metering block and tighten retaining screws.
13. Apply petroleum jelly to fuel line tube "O" ring seal. Place seal against flange on one end of fuel line tube. Install this end of fuel line tube into recess in primary fuel bowl.

SECONDARY FUEL BOWL and METERING BOWL REASSEMBLY

1. Assemble secondary fuel bowl and perform float adjustment (dry) by following Steps 3-thru-8 under "Primary Fuel Bowl and Metering Block Reassembly", preceding in this section.
2. Slide metering body gasket (Figure 3) into position on main body. Position metering plate gasket, metering plate, gasket and metering body on main body and install retaining screws. (Figure 7)
3. Apply petroleum jelly to fuel line tube "O" ring seal and position seal against flange on fuel line tube. Position fuel bowl on main body, guiding fuel line tube into recess in bowl. Install retaining screws with new compression gaskets.
4. Refer to "Adjustments", following, and perform accelerating pump lever, accelerating pump stroke and automatic choke adjustments.

INSTALLATION

1. Be sure all old gasket material is removed from manifold and carburetor mounting flanges. Place new carburetor mounting gasket on manifold.
2. Position carburetor on intake manifold. Connect choke heat wires to carburetor. Install carburetor retaining nuts and tighten evenly and alternately to specifications.
3. Tighten choke heat tube fitting at carburetor. Install new retaining clamp on fuel inlet hose. Install hose on fuel inlet fitting. Tighten retaining clamp.
4. Adjust engine idle speed and idle fuel mixture. Refer to "Adjustments", following, for proper procedure.
5. Install flame arrestor and mounting gaskets.

ADJUSTMENTS

Fuel level float adjustment (dry) and secondary throttle plate adjustment are performed only as bench adjustments. Preliminary idle fuel mixture and idle speed adjustments, automatic choke adjustment and accelerating pump lever and stroke adjustments can be performed with carburetor on bench or installed on engine.

Fuel lever adjustment, carburetor inter-connecting linkage adjustment, idle fuel mixture and idle speed adjustments are performed only with carburetor installed on engine.

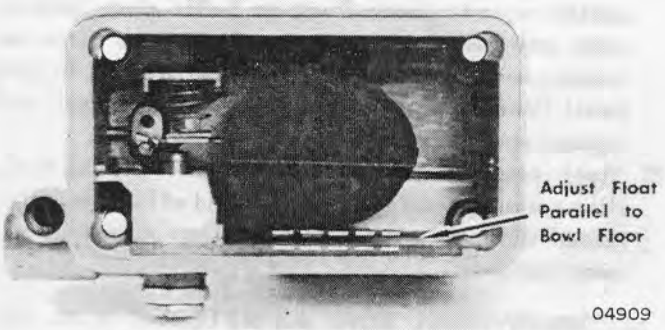


Figure 11. Dry Float Level Adjustment

FLOAT LEVEL ADJUSTMENT (DRY)

With float bowl upside down, adjust float parallel to bowl floor (Figure 11) by loosening lock screw and turning adjusting nut.

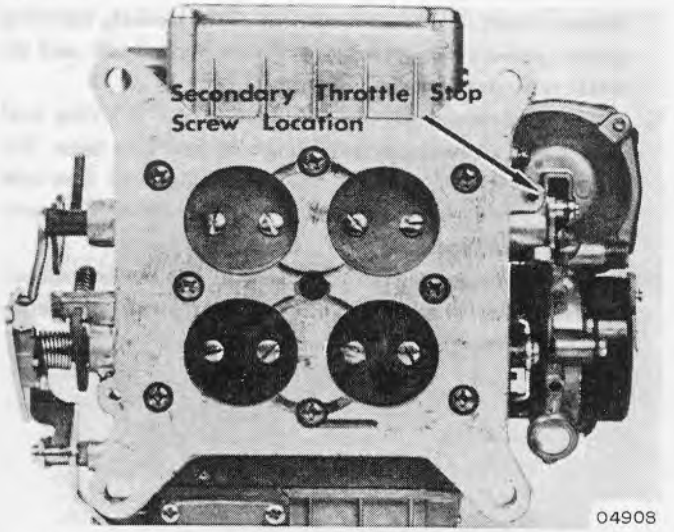


Figure 12. Secondary Throttle Stop Screw Location

SECONDARY THROTTLE STOP SCREW ADJUSTMENT

Back secondary throttle stop screw out until secondary throttle plates are closed in the base. Turn screw in until it touches the stop on lever, then add ½-turn.

ACCELERATOR PUMP LEVER CLEARANCE

1. With throttle valves at wide open throttle and pump lever held down, insert a .015" minimum gauge between adjusting nut and operating lever. (Figure 13)
2. Adjust pump over-ride screw until correct clearance is obtained.

NOTE: There must be no free movement of pump leverage when throttle is at idle.

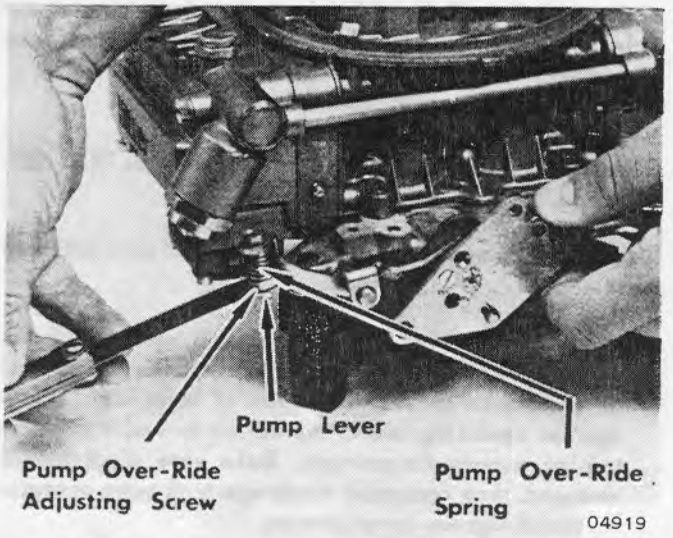


Figure 13. Accelerator Pump Lever Clearance

CHOKE UNLOADER ADJUSTMENT

Choke unloader is a mechanical device to partially open choke at wide open throttle. Adjust as follows:

1. Hold throttle valves in wide open position, insert a 5/32" drill between upper edge of choke valve and inner wall of air horn.
2. Press finger lightly against choke control lever. A slight drag should be felt as drill is pulled out. (Figure 14)
3. To adjust, bend tab on kick-down lever until correct opening has been obtained.

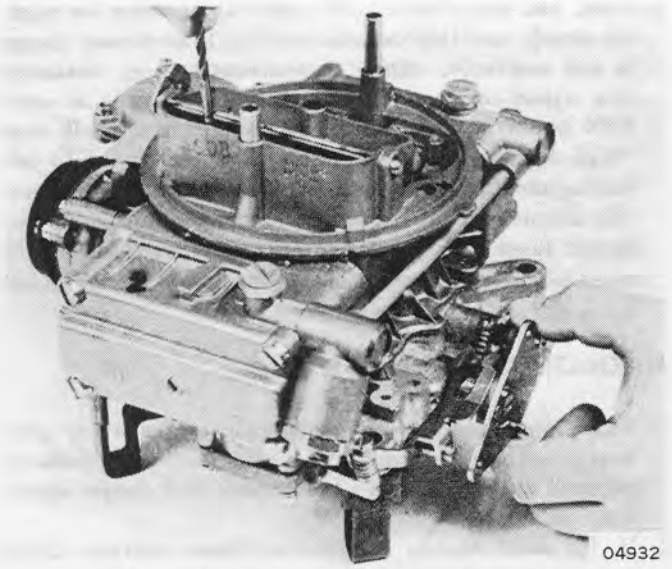


Figure 14. Choke Unloader Adjustment

FLOAT LEVEL ADJUSTMENT (WET)

1. With flame arrestor removed and ignition "off", remove sight plug (Figure 15), then remove bowl lower attaching screw furthest from fuel inlet. (Figure 16)
2. Drain off fuel into a shallow pan, using care not to spill fuel and create a fire hazard.
3. Reinstall fuel bowl screw.

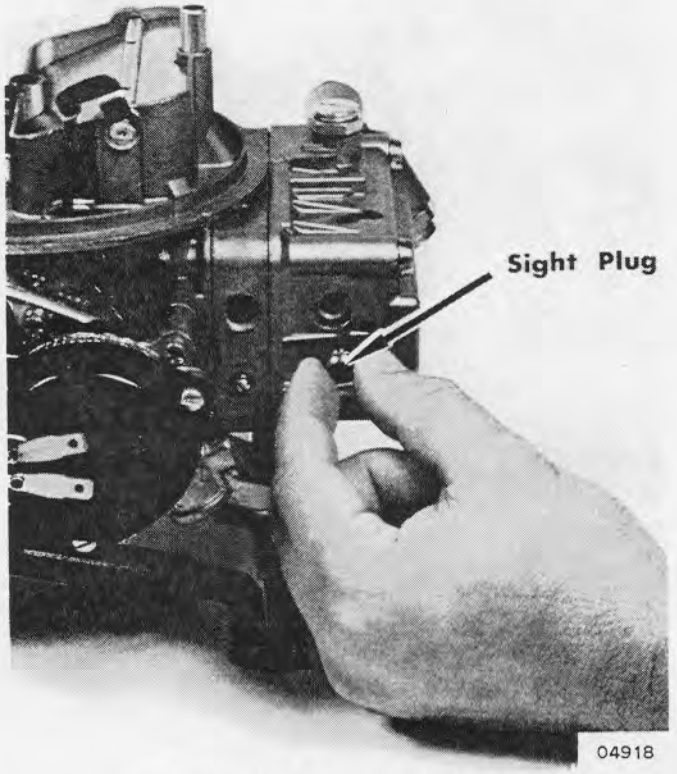


Figure 15. Removing Sight Plug

4. With engine running, fuel level should be on line with threads at bottom of sight plug port (plus-or-minus 1/32" [.8mm] tolerance).
5. To correct fuel level, loosen lock screw (Figure 17) and turn adjusting nut clockwise to lower fuel level and counterclockwise to raise fuel level (1/6-turn of adjusting nut equals approximately 1/16" [1.6mm] in fuel level).
6. After adjustment, tighten lock screw.
7. Operate engine until fuel level is stablized, then recheck level at sight plug.

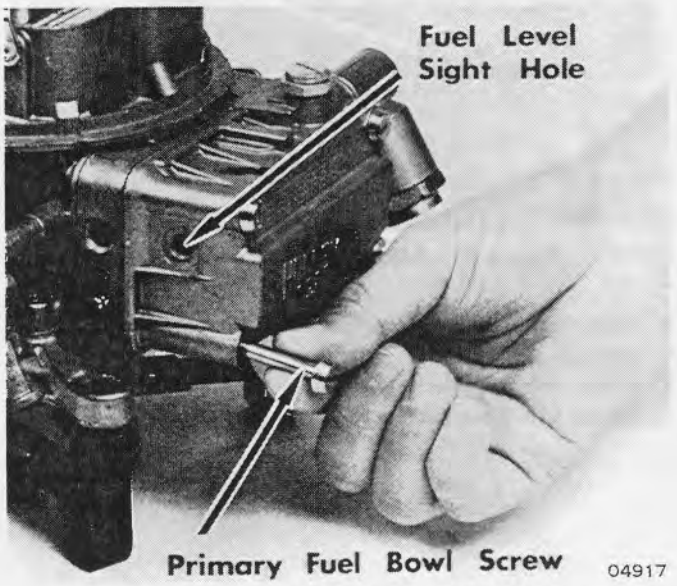


Figure 16. Removing Fuel Bowl Lower Screw

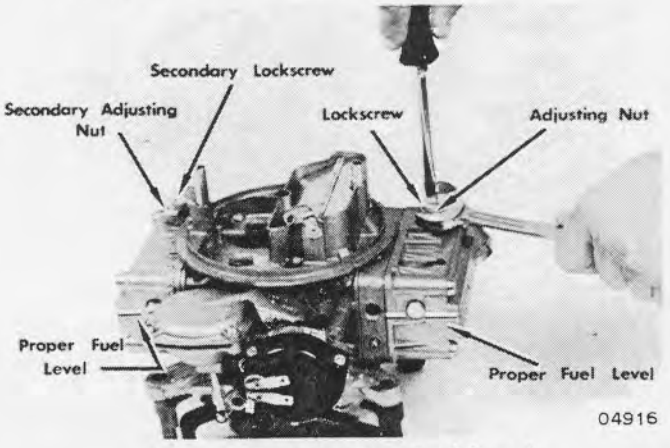


Figure 17. Adjusting Fuel Level

8. If necessary, repeat adjustment until proper fuel level is attained.
9. Replace sight plug.
10. This procedure should be used on primary and secondary fuel bowl.

IDLE SPEED and MIXTURE ADJUSTMENT

1. Adjustment must be made with boat as level as possible.
2. Seat idle adjusting needles lightly and back each off a full turn, if there is doubt that this was not done during reassembly. (Figure 18)

NOTE: When seating idle adjusting needle, care must be taken not to turn screw tight against seat, thus grooving tip of needle. If needle becomes grooved, a smooth idle cannot be obtained.

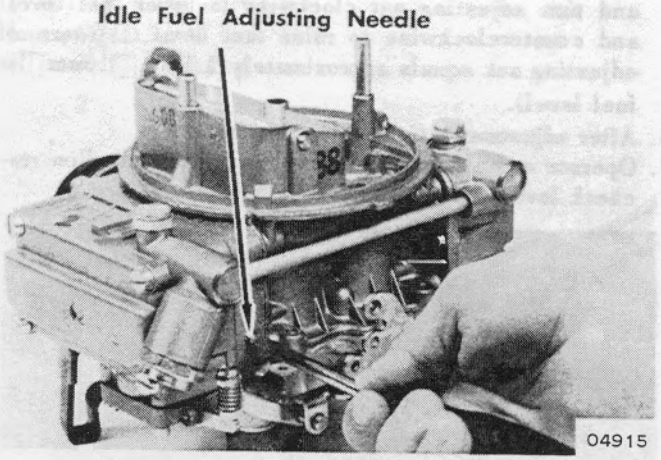


Figure 18. Adjusting Idle Fuel Mixture

3. Start engine and allow operating temperature to reach normal.
4. After engine reaches normal operating temperature, adjust idle speed screw to idle engine at specified RPM.
5. First, set one of the 2 idle adjusting needles for highest steady manifold vacuum reading. If a vacuum gauge is not available, obtain smoothest-running, maximum idle speed by turning idle adjusting needle in until RPM begins to drop off, then backing needle off over "high spot" until RPM again drops off. Set idle adjusting needle halfway between 2 points for satisfactory idle mixture setting. Repeat procedure with other needle. Should these adjustments shown an increase in idle RPM, reset idle speed screw to obtain specified idle RPM and again adjust idle adjusting needles.

AUTOMATIC CHOKE ADJUSTMENT

1. Automatic choke is set accurately at factory to give best possible all-weather operation. To return choke to original setting, line up index mark with proper specification.
2. If, for some reason, a richer or leaner mixture during warm-up period is desired, it can be obtained by rotating thermostat cover. Never set index mark on cover more than 2 graduations off specified settings.

"MD" SERIES CARBURETOR

MERCRUISER "60" MARINE ENGINE

DESCRIPTION

The "MD" series carburetor has been kept basically simple for ease of service. A constant gasoline level in the bowl and all channels is maintained by inlet needle and seat assembly and float.

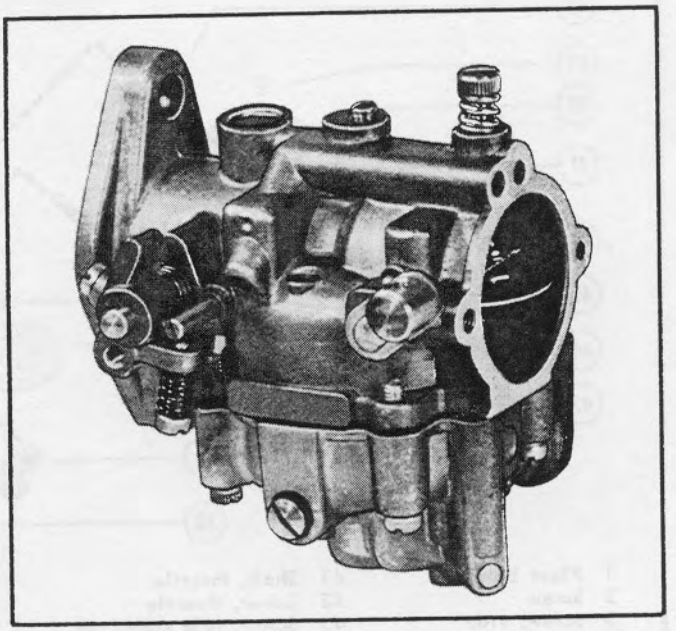


Figure 1. "MD" Series Carburetor

PRECAUTIONS

Before making carburetor adjustments, be sure that carburetor-to-manifold and manifold-to-cylinder head bolts are tight (to prevent air leaks). Warm up engine to operating temperature (at least 15 minutes), or carburetor misalignment will occur. Use only clean gasoline and compressed air to clean passages and discharge holes.

NOTE: NEVER use wire or other pointed instruments to clean passages or orifices, or calibration of carburetor will be affected.

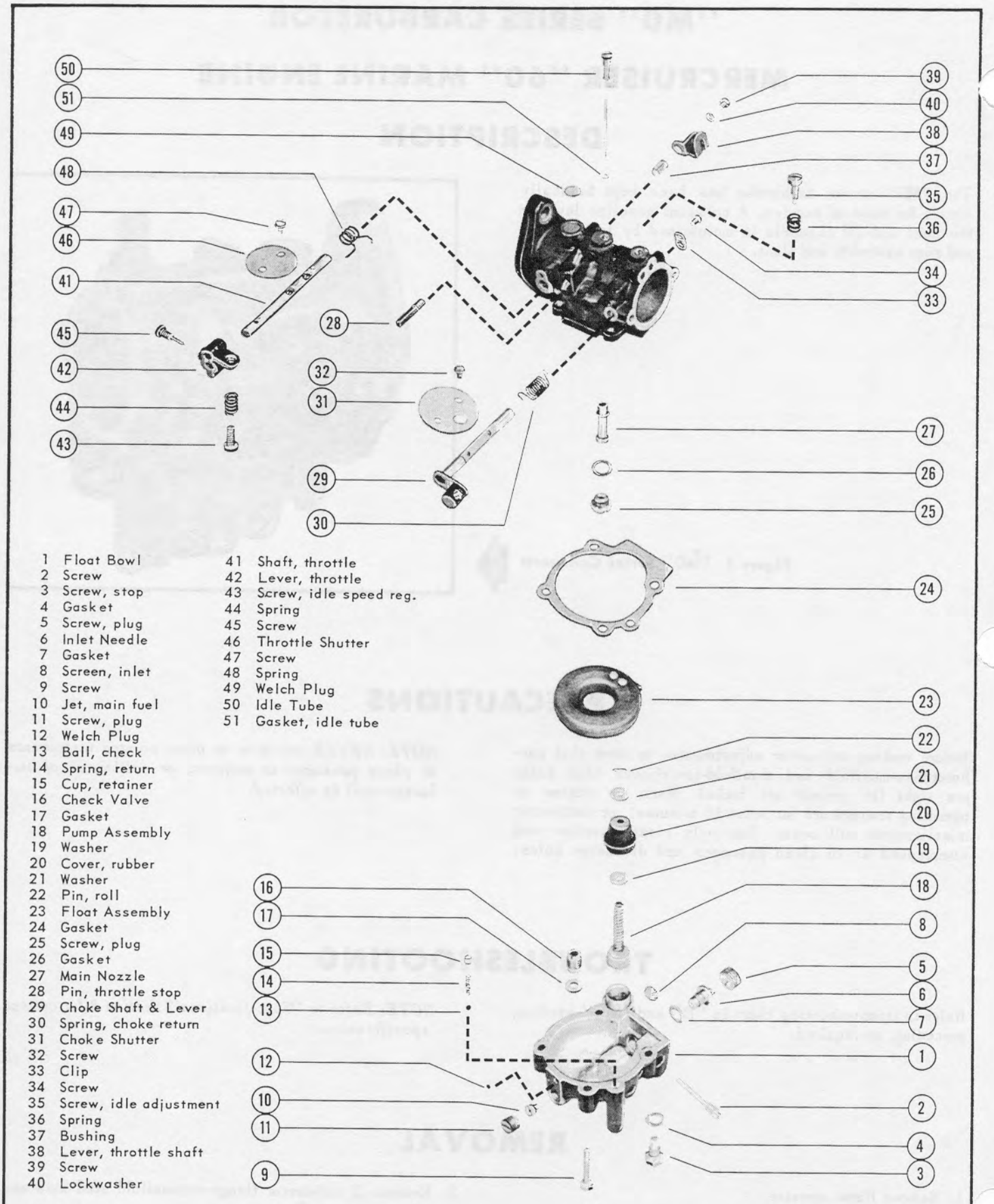
TROUBLESHOOTING

Refer to troubleshooting chart in "B" and "BC" section, preceding, as required.

NOTE: Refer to "Specifications" Section 8 for current specifications.

REMOVAL

1. Remove flame arrestor.
2. Remove fuel line and throttle connections.
3. Remove 2 carburetor flange-to-manifold stud nuts and lift carburetor off.



1 Float Bowl
2 Screw
3 Screw, stop
4 Gasket
5 Screw, plug
6 Inlet Needle
7 Gasket
8 Screen, inlet
9 Screw
10 Jet, main fuel
11 Screw, plug
12 Welch Plug
13 Ball, check
14 Spring, return
15 Cup, retainer
16 Check Valve
17 Gasket
18 Pump Assembly
19 Washer
20 Cover, rubber
21 Washer
22 Pin, roll
23 Float Assembly
24 Gasket
25 Screw, plug
26 Gasket
27 Main Nozzle
28 Pin, throttle stop
29 Choke Shaft & Lever
30 Spring, choke return
31 Choke Shutter
32 Screw
33 Clip
34 Screw
35 Screw, idle adjustment
36 Spring
37 Bushing
38 Lever, throttle shaft
39 Screw
40 Lockwasher
41 Shaft, throttle
42 Lever, throttle
43 Screw, idle speed reg.
44 Spring
45 Screw
46 Throttle Shutter
47 Screw
48 Spring
49 Welch Plug
50 Idle Tube
51 Gasket, idle tube

Figure 2. "MD" Series Carburetor Exploded View

DISASSEMBLY

NOTE: Only rear carburetor is equipped with a choke, however, repair procedure is identical for both carburetors.

1. Remove pump lever screw from throttle shaft. (Figure 3)
2. Remove body retaining screws and lockwashers and separate upper body and float bowl assembly. (Figures 4-4A)
3. Remove float lever pin and float from float bowl. (Figure 5)
4. Remove large plug screw, then inlet needle, seat and gasket from float bowl. (Figure 5)
5. Remove idle adjustment screw, spring, idle tube and main nozzle channel plug screw from upper body. (Figure 6)
6. Be sure that fuel delivery hole (in head of idle tube) is open. (Figure 7)

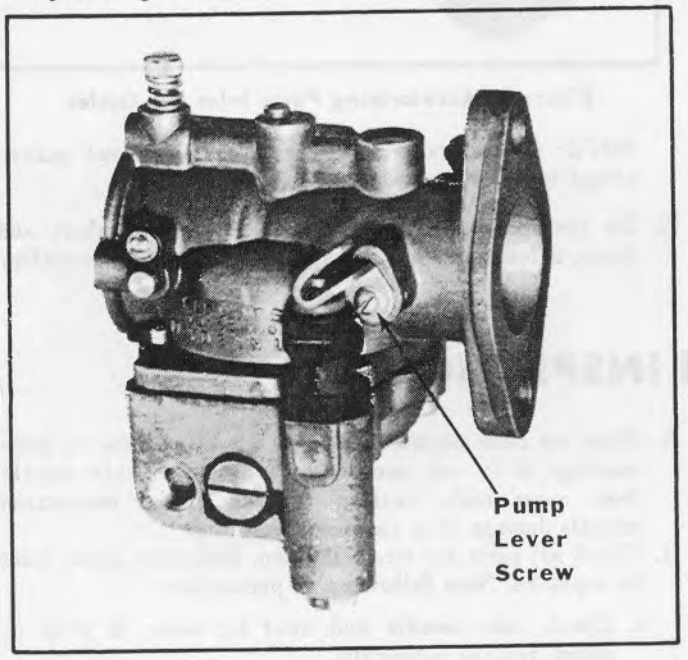


Figure 3. Pump Lever Screw

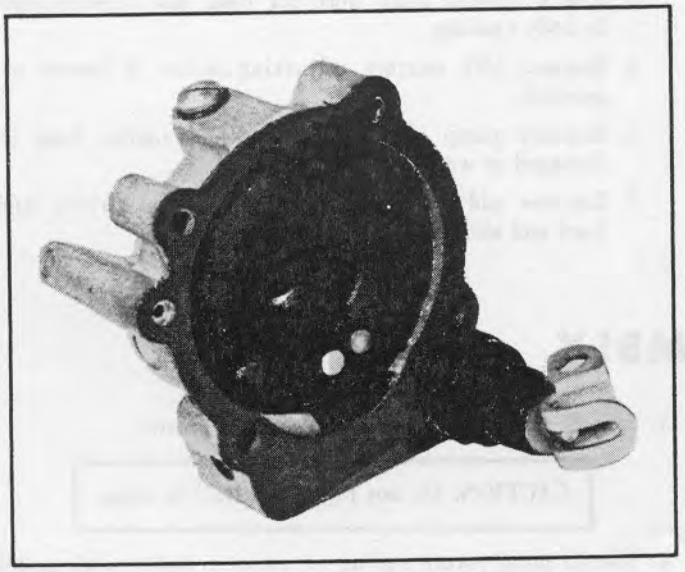


Figure 4. Float Bowl Assembly

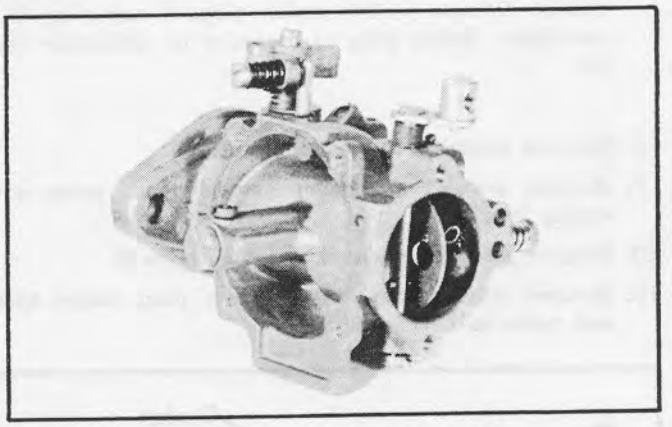


Figure 4A. Upper Body Assembly

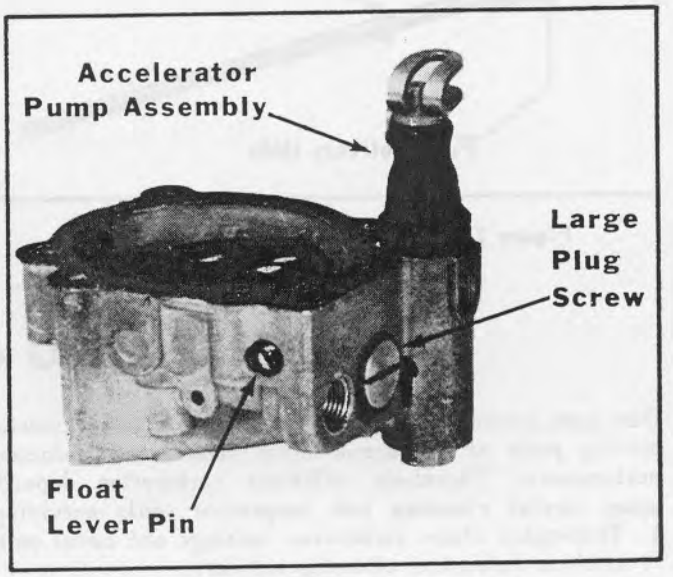


Figure 5. Float Bowl Components

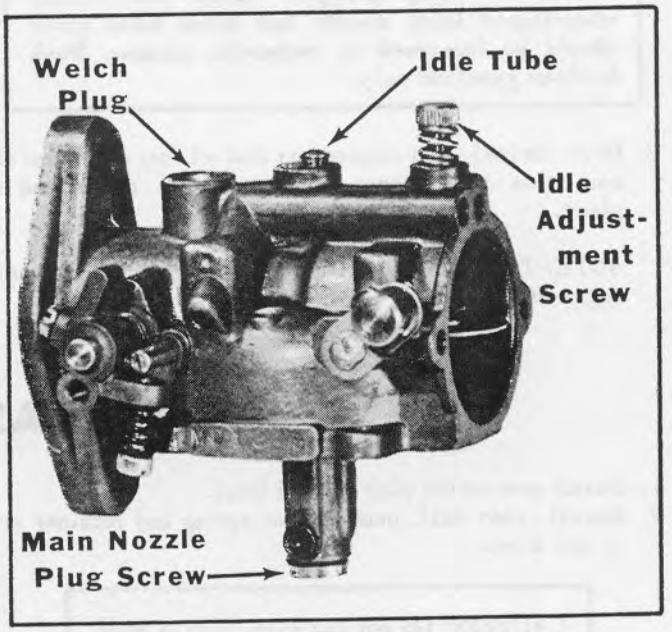


Figure 6. Upper Body Components

7. Remove welch plug to inspect by-pass holes. (Figure 6)

NOTE: Do not remove welch plug, if new plug is not available. Welch plug is included in carburetor repair kit.

8. Remove throttle shutter and shaft.
9. Remove accelerating pump assembly and pump return spring from bowl.
10. Remove pump inlet check valve. (Figure 8)
11. Remove retainer cup, then remove pump outlet spring and nylon ball. (Figure 8)

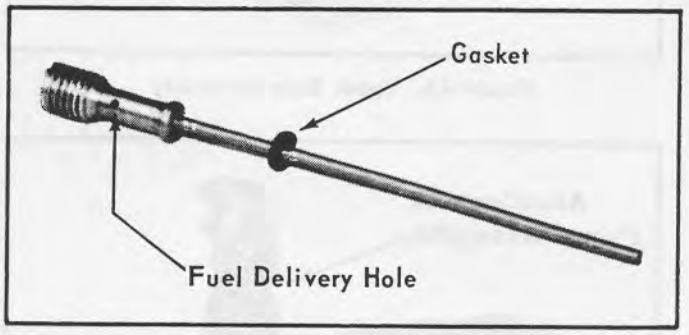


Figure 7. Fuel Delivery Hole in Idle Tube

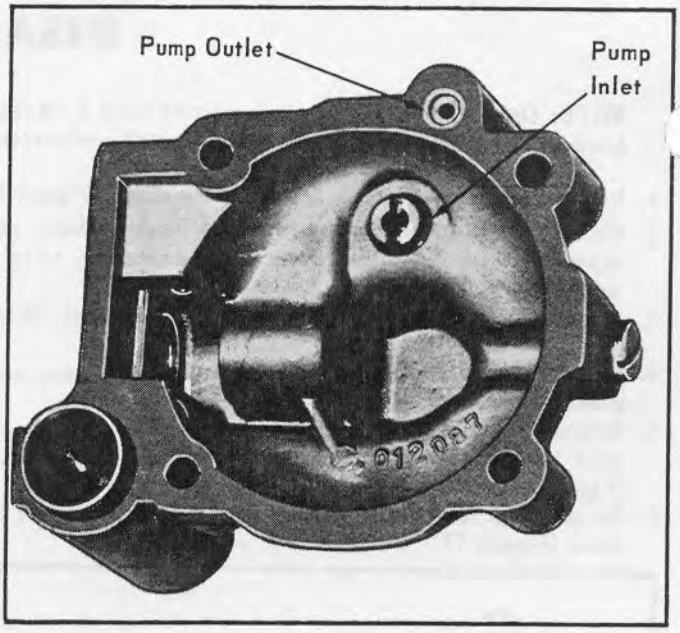


Figure 8. Accelerating Pump Inlet and Outlet

NOTE: Do not remove welch plug from bowl unless complete carburetor repair kit is used.

12. Do not remove or replace choke shutter, shaft and lever, unless they are damaged or broken accidentally.

CLEANING and INSPECTION

Dirt, gum, water or carbon contamination in or on exterior moving parts of carburetor often causes unsatisfactory performance. Therefore, efficient carburetion depends upon careful cleaning and inspection while servicing.

1. Thoroughly clean carburetor castings and metal parts in clean carburetor cleaning solvent.

CAUTION: Pump plunger, rubber boot, float, viton-tipped inlet needle and nylon balls never should be immersed in carburetor cleaner. Wash in clean gasoline only.

2. Blow out fuel inlet connection and all fuel channels. Be sure that inlet connection screen is clean and in place.

NOTE: DO NOT use wires or drills for cleaning passages or orifices.

3. Blow out main nozzle and main air bleed tube in body casting. It is not necessary to remove main nozzle from upper body casting, unless visual inspection reveals damage from careless handling.
4. Check all parts for wear. If worn, defective parts must be replaced. Note following in particular:
   a. Check inlet needle and seat for wear. If wear is noted, replace assmebly.
   b. Check float hinge and float lever pin for wear.
   c. Check throttle shaft bore for wear and out-of-round in body casting.
   d. Replace idle mixture adjusting screw if burred or grooved.
   e. Replace pump plunger leather and rubber boot if damaged or worn.
   f. Replace old gaskets. Gaskets become brittle and hard and should not be reused.

REASSEMBLY

1. Install new welch plug in fuel bowl.
2. Install nylon ball, pump outlet spring and retainer cup in fuel bowl.

CAUTION: Do not tap nylon ball in bowl.

3. Install pump inlet check valve in fuel bowl.

CAUTION: Do not tap nylon ball in cage.

4. Install pump return spring in pump cylinder with small end up. (Figure 9)

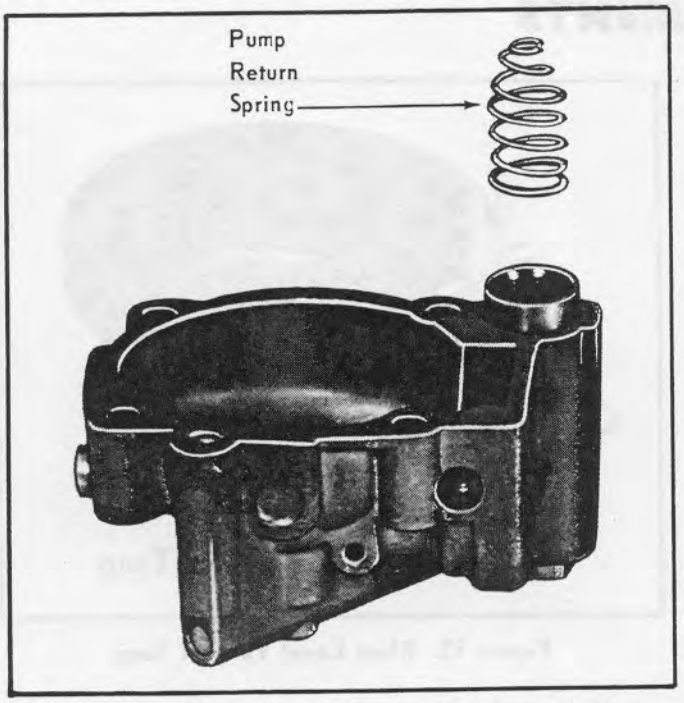


Figure 9. Pump Return Spring and Pump Cylinder

5. Install pump plunger in pump cylinder carefully so that leather will not be damaged.
6. Install inlet seat and needle and large plug screw.
7. Install float assembly and float lever pin. Be sure that yoke or slotted end of float lever is inserted thru groove around blunt end of inlet needle so that float movement will control the inlet needle. (Figure 10)
8. Check float level as outlined under "Float Level Adjustment", following.
9. Install new welch plug in recess over by-pass holes in upper body assembly.
10. Install throttle shaft and shutter.
11. Install idle tube and gasket in upper body assembly. After installing, blow out with compressed air to insure that all chips are removed.
12. Install main nozzle channel plug screw.
13. Install idle mixture adjustment screw and spring. Turn screw in until it seats lightly, then back out one full turn.
14. Reassemble bowl to upper body. Use new gasket.
15. Assemble pump lever to throttle shaft with screw and lockwasher. Loosen throttle shutter screws before tightening pump lever screw. Back idle speed screw out until throttle shutter is completely closed, then tighten shutter screws. (Figure 11)

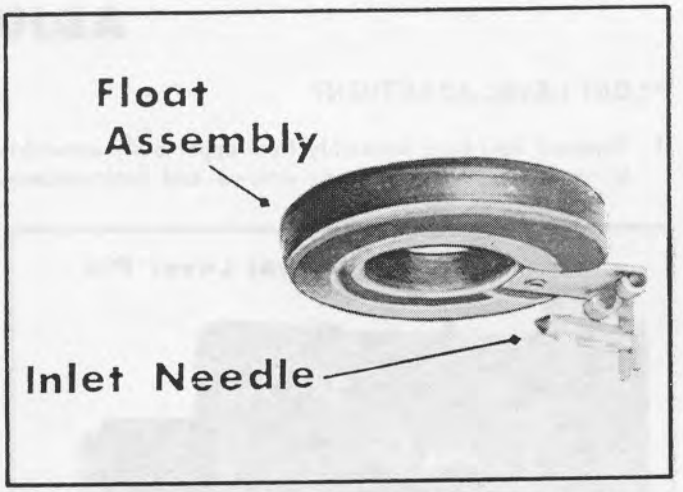


Figure 10. Float Lever Installed on Inlet Needle

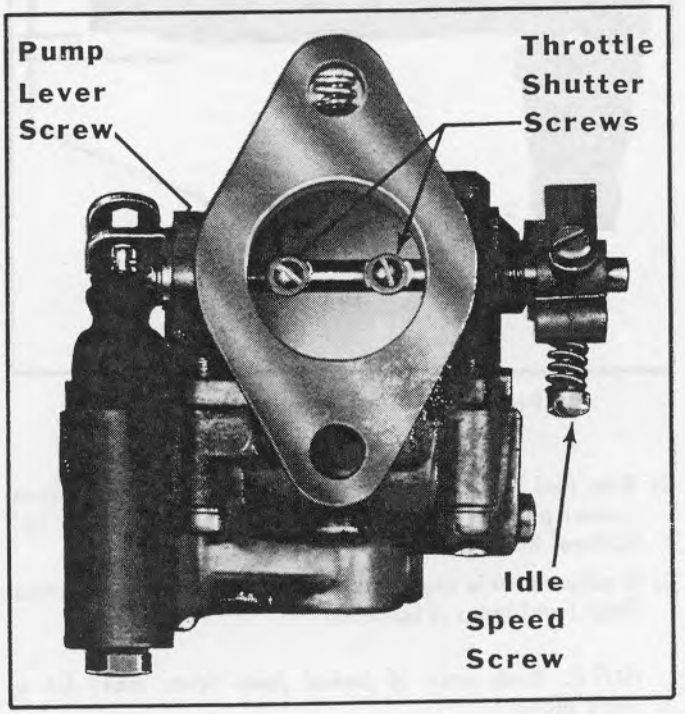


Figure 11. Pump Lever on Throttle Shaft

CAUTION: Check for sticking throttle shutter before installing on engine.

INSTALLATION

1. Install carburetor to manifold with 2 flange-to-manifold stud nuts.
2. Install fuel line and throttle connections.
3. Install flame arrestor.

ADJUSTMENTS

FLOAT LEVEL ADJUSTMENT

1. Separate fuel bowl assembly from upper body assembly by removing body retaining screws and lockwashers.

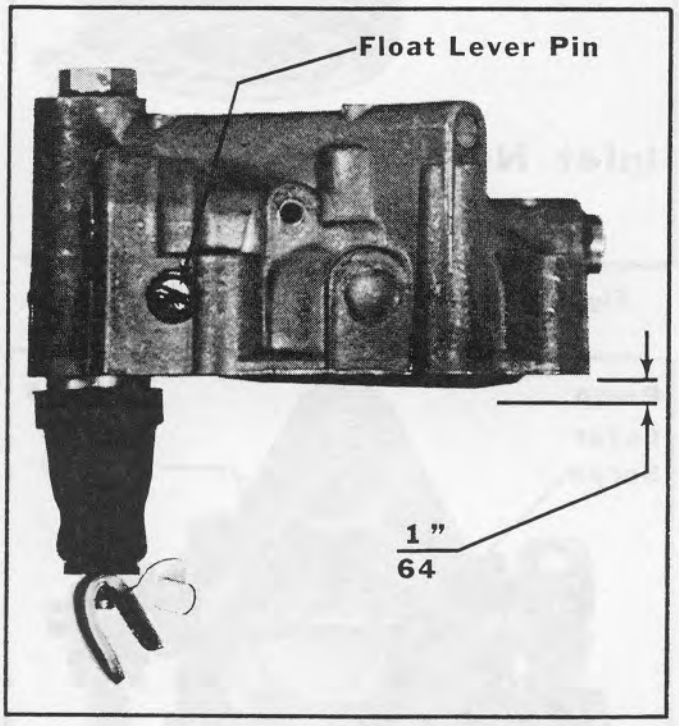


Figure 12. Float Level Adjustment

2. With fuel bowl assembly held in upside-down position, lowest point of float (at free end) should project 1/64" (.39mm) below rim of float bowl. (Figure 12)
3. If adjustment is required, remove float and bend vertical float level tang. (Figure 13)

   NOTE: Both arms of forked float lever must lie in same plane.

4. If inspection indicates that fuel level continues to rise beyond float setting point, proceed as follows:

   a. Remove inlet needle and seat and clean mating surfaces with a clean soft cloth.

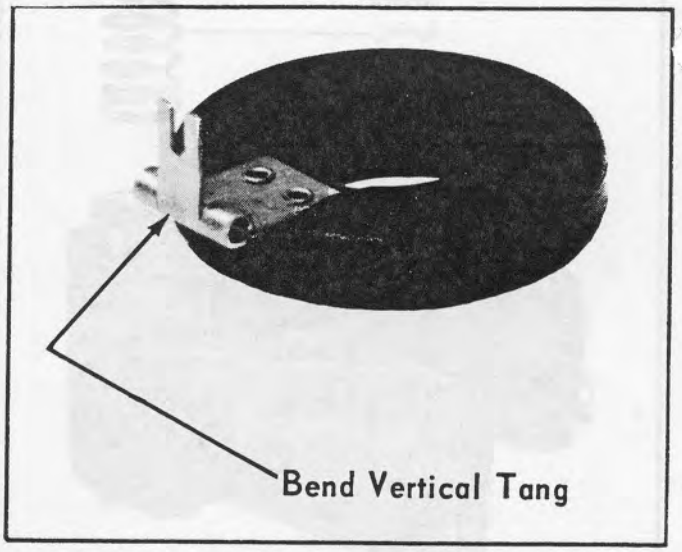


Figure 13. Float Level Vertical Tang

   b. Reinstall inlet needle in seat, being careful not to force viton-tipped needle into seat, as this may cause sticking.

   c. If proper fuel level is not maintained, install a new needle and seat assembly.

CAUTION: DO NOT change float level from recommended specifications.

IDLE and MIXTURE ADJUSTMENTS

1. Thoroughly warm up engine. If engine is cold, allow to run for at least 15 minutes.
2. Inspect torque of carburetor to manifold bolts and manifold-to-cylinder head bolts to exclude possibility of air leaks.
3. Adjust idle speed to 650 RPM (as indicated on tachometer).
4. Adjust idle mixture screws (both carburetors) until smooth slow speed performance is obtained.

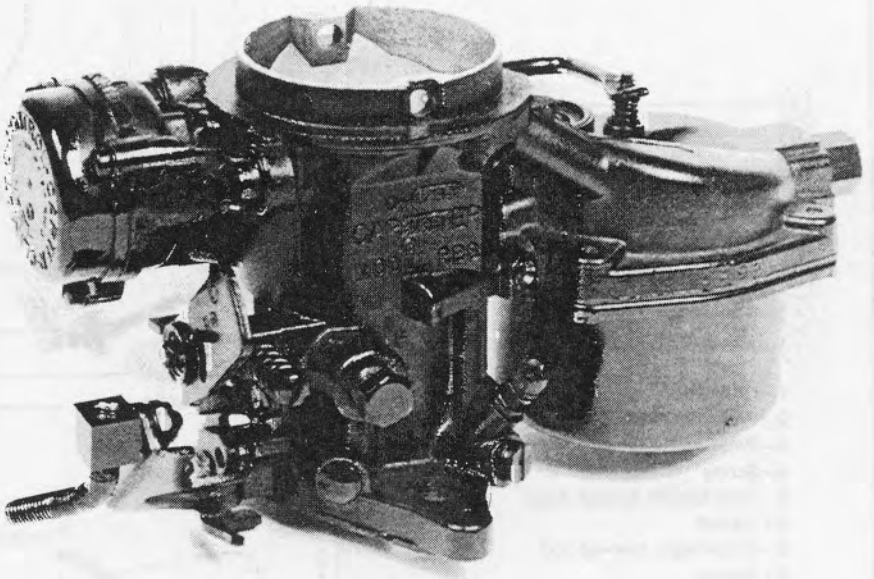
   NOTE: Regardless of altitude or climatic conditions, secure proper idle adjustment by following above procedure.

"RBS" SERIES CARBURETOR
MERCRUISER "80" MARINE ENGINE

DESCRIPTION

The "RBS" series carburetor has been kept basically simple for ease of service. A constant gasoline level in bowl and all channels of this carburetor is maintained by inlet needle and seat assembly and float.

Figure 1.
"RBS" Series
Carburetor



PRECAUTIONS

Before making carburetor adjustments, make sure that carburetor-to-manifold and manifold-to-cylinder head bolts are tight to prevent air leaks. Engine must be warmed up to operating temperature, or carburetor misalignment will occur. Allow engine to run for at least 15 minutes. Use only clean gasoline and compressed air to clean passages and discharge holes.

NOTE: NEVER use wire or other pointed instruments to clean passages or orifices, or calibration of carburetor will be affected. DO NOT remove any jets or plugs which are not required in disassembly, cleaning and inspection instructions.

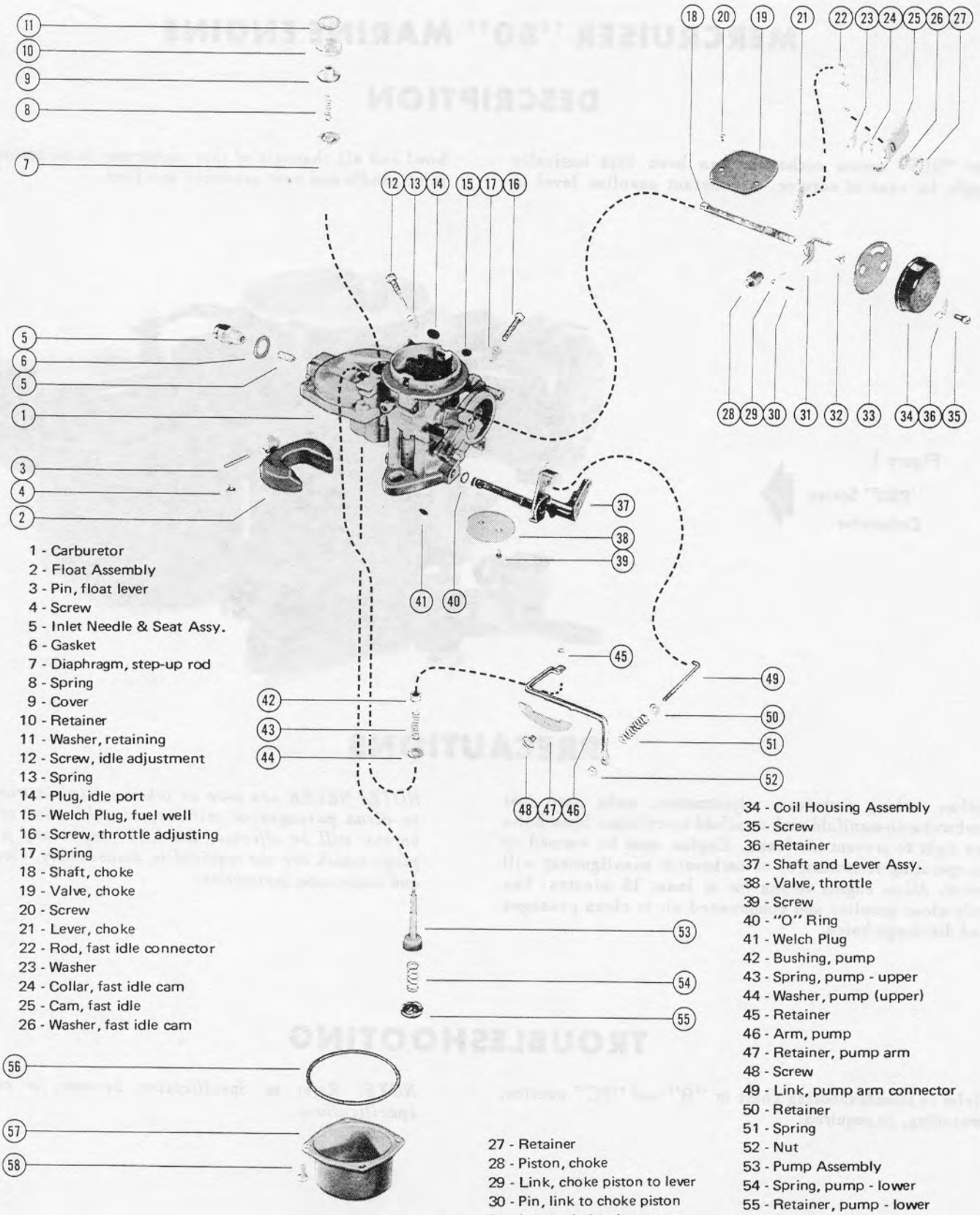
TROUBLESHOOTING

Refer to troubleshooting chart in "B" and "BC" section, preceding, as required.

NOTE: Refer to Specification Section for current specifications.

REMOVAL

1. Remove flame arrestor.
2. Remove fuel line and throttle connections.
3. Remove 2 carburetor flange-to-manifold stud nuts and lift carburetor off.



1 - Carburetor
2 - Float Assembly
3 - Pin, float lever
4 - Screw
5 - Inlet Needle & Seat Assy.
6 - Gasket
7 - Diaphragm, step-up rod
8 - Spring
9 - Cover
10 - Retainer
11 - Washer, retaining
12 - Screw, idle adjustment
13 - Spring
14 - Plug, idle port
15 - Welch Plug, fuel well
16 - Screw, throttle adjusting
17 - Spring
18 - Shaft, choke
19 - Valve, choke
20 - Screw
21 - Lever, choke
22 - Rod, fast idle connector
23 - Washer
24 - Collar, fast idle cam
25 - Cam, fast idle
26 - Washer, fast idle cam
27 - Retainer
28 - Piston, choke
29 - Link, choke piston to lever
30 - Pin, link to choke piston
31 - Lever, choke piston
32 - Screw
33 - Gasket, coil housing
34 - Coil Housing Assembly
35 - Screw
36 - Retainer
37 - Shaft and Lever Assy.
38 - Valve, throttle
39 - Screw
40 - "O" Ring
41 - Welch Plug
42 - Bushing, pump
43 - Spring, pump - upper
44 - Washer, pump (upper)
45 - Retainer
46 - Arm, pump
47 - Retainer, pump arm
48 - Screw
49 - Link, pump arm connector
50 - Retainer
51 - Spring
52 - Nut
53 - Pump Assembly
54 - Spring, pump - lower
55 - Retainer, pump - lower
56 - Gasket, float bowl
57 - Bowl, float - carburetor
58 - Screw

Figure 2. "RBS" Series Carburetor Exploded View

DISASSEMBLY

1. Remove pump adjusting nut. Remove retaining clip from pump shaft. Remove arm retaining screw, retainer and arm, then remove spring, stop and washers from pump shaft. Remove cupped washer and spring from connector link. DO NOT remove connector link. (Figure 3)

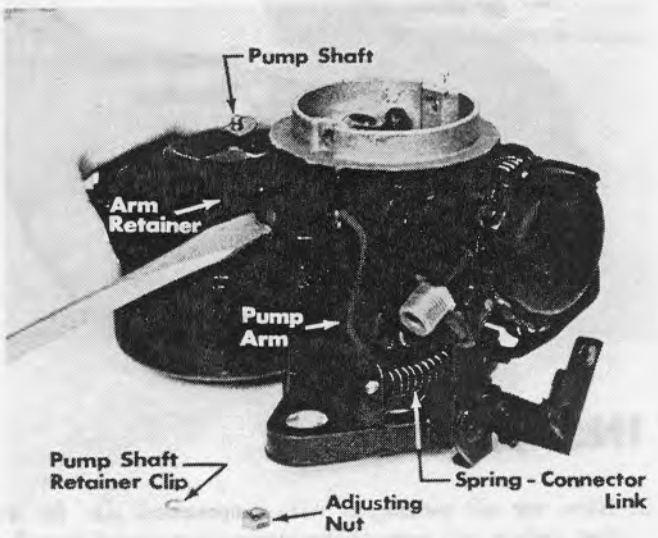


Figure 3. Removing Choke Connector Rod

2. Only if required for replacement, remove unloader cam retainer, washer and cam, then disengage choke connector rod. (Figure 4)
3. To clean choke chamber or to replace parts, remove 3 coil housing retainer screws, retainers, thermostatic coil housing and gasket. Remove screw and piston lever, then slide piston out of cylinder. Disconnect choke piston link. (Figure 4)

Figure 4. Removing Choke Components

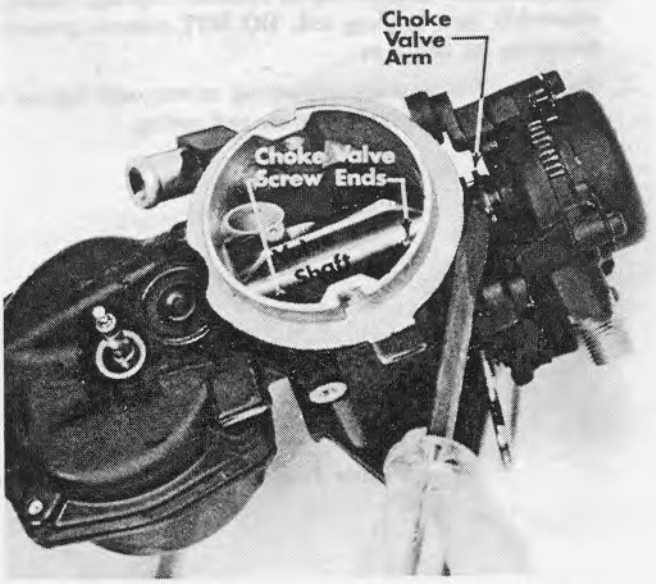


Figure 5. Removing Choke Valve Arm

If replacing choke valve and shaft, file off staked ends of choke valve screws, then remove choke valve screws and valve. Spread fork of choke lever (Figure 5), remove lever from shaft and slide shaft from air horn.

4. Remove seat and needle from body casting. Remove 4 attaching screws, bowl and bowl gasket, then remove 2 float pin attaching screws, float, pin and baffle.
5. Press pump plunger shaft downward as far as it will go. Using end of pump arm, tap shaft end with light hammer. Catch plunger, spring and retainer as they are driven from lower end of cylinder. (Figure 6)

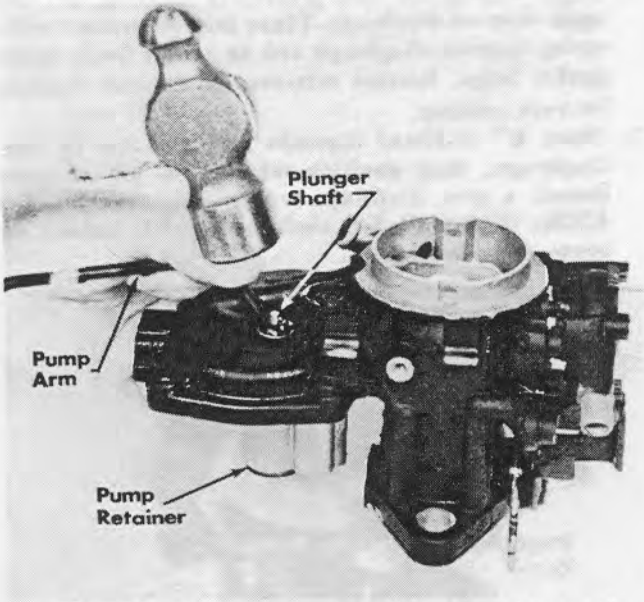


Figure 6. Plunger Spring and Retainer Removal

6. Remove step-up rod and replace with new parts when rod sticks, becomes damaged or is in need of cleaning.

Pry washer out of diaphragm cover with screwdriver. (Figure 7) Pierce diaphram cover with screwdriver blade and pry cover out of casting, using bowl vent as a fulcrum. Remove lower retainer, spring, diaphragm assembly and step-up rod. DO NOT remove pressed-in metering jet or plugs.

7. Remove idle mixture adjusting screw and spring and throttle lever adjusting screw and spring.

Figure 7. Removing Diaphragm Cover

CLEANING and INSPECTION

1. If bore of carburetor shows gum or carbon accumulation at throttle valve seat or on casting and parts, clean in solvent or other carburetor cleaner. Do not immerse needle seat, step-up diaphragm, plunger or float in carburetor cleaning solution, if they were not removed. Use gasoline.
2. Blow out all passages with compressed air. Be sure that carbon and gum accumulation is removed from bore of carburetor.

REASSEMBLY

1. Guide step-up rod thru pressed-in metering jet, using upper stem on diaphragm. Place brim of retainer without spring to press diaphragm and its gasket firmly against gasket ledge. Remove retainer and examine diaphragm for even seating.
2. Place ¼" (6.35mm) diameter spring in cup on top of diaphragm, then position retainer on top of spring. Install a new diaphragm cover with tool No. C-91-47256. (Figure 8) Tap tool lightly with hammer until cover seats in casting.

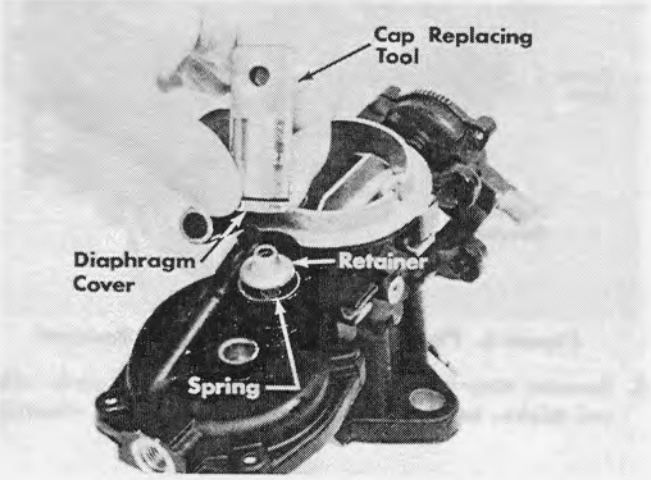


Figure 8. Installing Diaphragm Cover

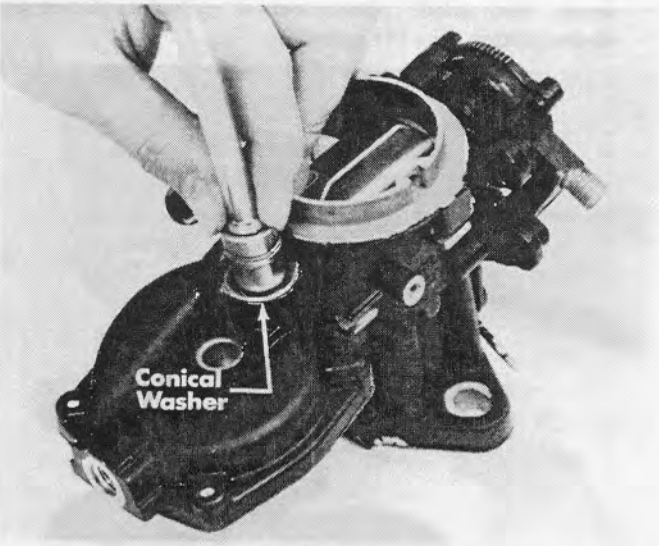


Figure 9. Securing Diaphragm Cover

3. Place split ring inside diaphragm cover and position conical washer over ring, cone end pointing up. Place a 7/16" socket with extension over cone washer and tap with hammer until conical washer is flat. Do not use a smaller tool, which will hit center portion of cover, and do not drive washer beyond flat position. (Figure 9)

4. Invert casting on bench and install pump plunger in cylinder with 3/8" (9.6mm) diameter lower pump spring in end of plunger. Place retainer cap over parts and insert into cylinder. Press cap down with tool No. C-91-47256. Tap lightly with hammer to seat cap in place. Use new cap to assure good seal in casting. (Figure 10)
5. Install float bowl and fuel intake needle and seat. Insert float pin in float bracket, position baffle to cover vent in casting, then float, aligning its pin under baffle in pin recess. (Figure 10) Secure float with 2 attaching screws and set float level according to "Float Level Adjustment", following.

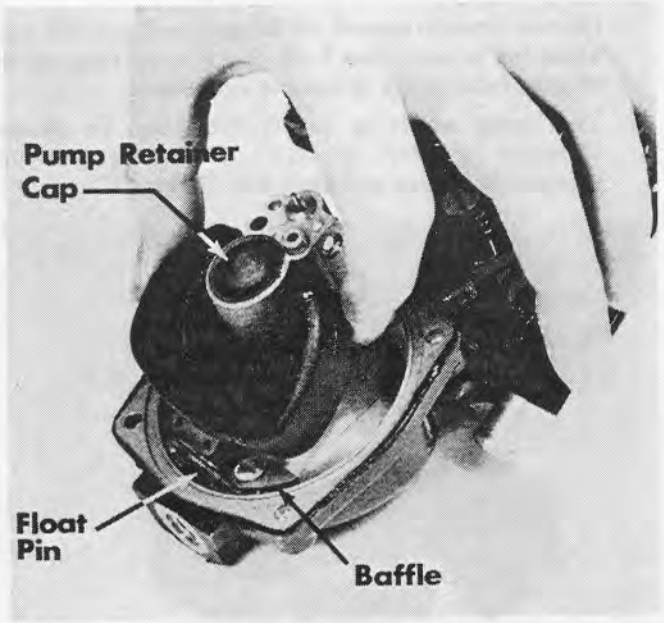


Figure 10. Installing Float and Baffle

6. If choke was completely disassembled, place choke shaft in air horn and install new choke lever with connector rod. Crimp forked ends of lever with pliers to secure in place. To install choke valve, center valve in bore by tapping lightly with screwdriver, hold in place and install new choke valve attaching screws. Stake ends of screws. Trade mark "C" should face up and extend toward accelerator pump arm side of carburetor, as viewed from top.

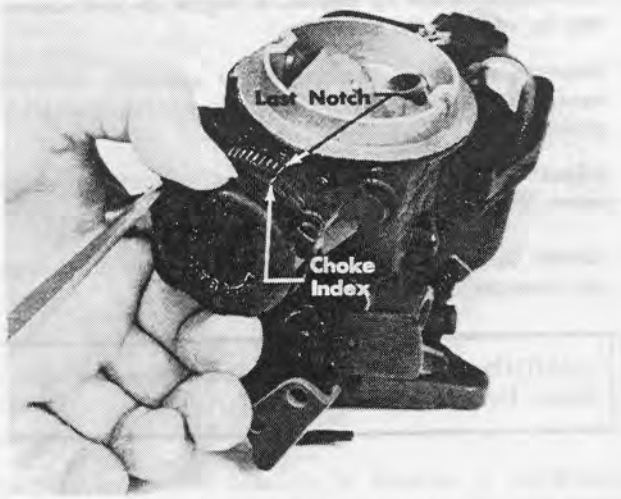


Figure 11. Setting Choke Lean

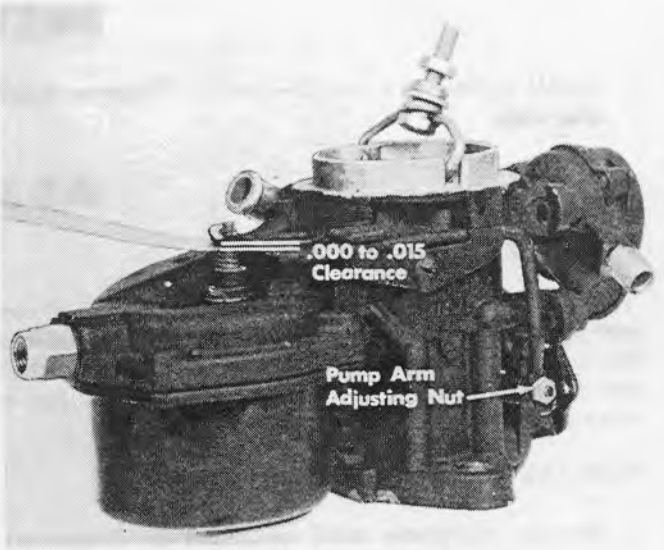


Figure 12. Obtaining Clearance

7. If choke assembly was removed, assemble choke piston and link to choke piston lever, slide piston into cylinder and position lever on end of shaft, securing with attaching screw. (Figure 4) Be sure that choke linkage moves freely and does not bind. Install choke housing gasket and thermostatic coil housing, revolving it counterclockwise once until index mark is on last notch lean and choke valve moves to open. Install 3 retainers and attaching screws. (Figure 11)

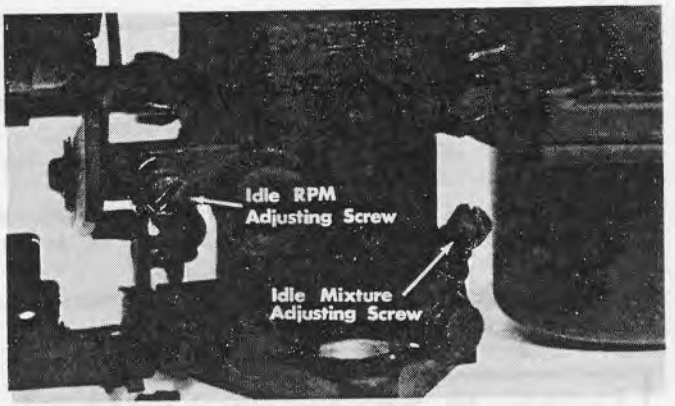


Figure 13. Carburetor Adjusting Screws

8. Reinstall washers, stop and ¼" (6.35mm) diameter spring over pump shaft. (Figure 12) Install cup washers (thin and thick) with spring on connector link. Install pump arm with connector link end thru lower end of arm and upper end of arm over pump shaft. Hold in place and install retainer and screw. (Figure 3) Install adjusting nut on connector link and retaining clip on pump shaft.
9. If unloader cam was removed, install washer (thick) on cam boss. Engage choke connector rod to unloader cam and slip over cam boss. Be sure that trade mark "C" (on cam) faces to outside, then install retainer washer (thin) and clip. (Figure 4)
10. Install throttle lever adjusting screw (idle) and spring. Install idle mixture screw and spring, being cautious not to damage casting by bottoming idle needle with force. (Figure 13)
11. Follow adjustment for pump and unloader as described in "Adjustments", following.

INSTALLATION

1. Install carburetor to manifold with 2 flange-to-manifold stud nuts.
2. Install fuel line and throttle connections.
3. Install flame arrester.

ADJUSTMENTS

FLOAT LEVEL ADJUSTMENT

This carburetor is equipped with a viton-tipped needle, and special precautions must be taken in adjustment, or the material will assume a "temporary set" if needle is pressed into seat. This will result in incorrect fuel level when temporary set is relieved.

NOTE: NEVER press needle into a seat.

1. Remove carburetor bowl (attached by 4 screws) and bowl gasket. Invert carburetor so that only weight of float is pressing needle into its seat.
2. Measure vertical distance from casting to second "bump" at outer ends of float. (Figure 14) Vertical distance at both ends of float should be 3/8" (9.5mm) plus-or-minus 1/32" (.8mm).
3. Adjust float by bending float bracket at narrowest portion.

CAUTION: Hold float up from needle when adjusting float level.

4. Install float bowl with gasket and 4 attaching screws.
5. If inspection indicates that fuel level continues to rise beyond float setting point, proceed as follows:
   a. Remove inlet needle and seat and clean mating surfaces with a clean, soft cloth.
   b. Reinstall inlet needle in seat, being careful not to force viton-tipped needle into seat, as this may cause sticking.
   c. If proper fuel level is not maintained, install a new needle and seat assembly

CAUTION: DO NOT change float level from recommended specifications.

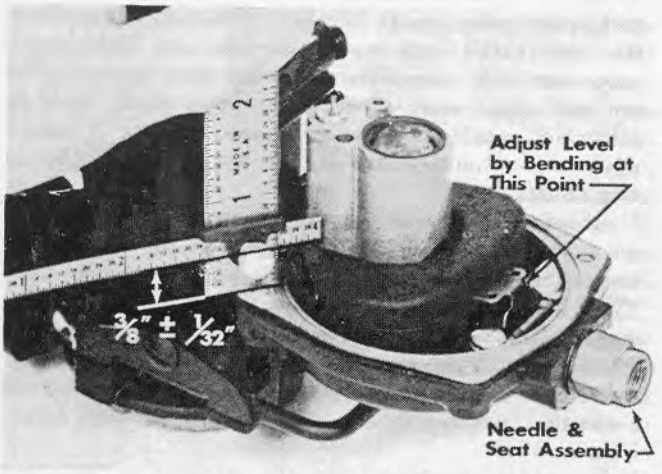


Figure 14. Measuring Vertical Distance and Adjustment

PUMP ADJUSTMENT

Complete pump adjustment each time carburetor is disassembled and before idle and unloader adjustments are made.

1. Remove throttle control cables and back out idle speed adjusting screw, then hold choke wide open so that throttle valve seats in base of carburetor.
2. Turn pump adjusting nut (self-locking) to obtain a clearance of .000" to .015" (.38mm) between pump plunger shaft boss and pump arm. (Figure 12)

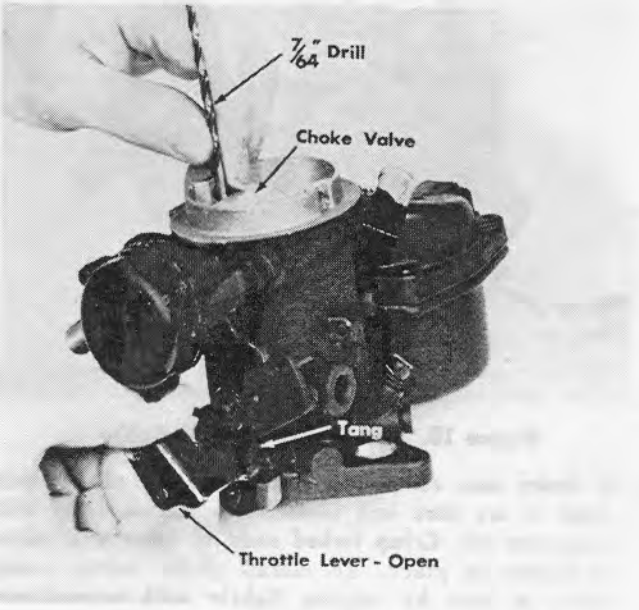


Figure 15. Choke Unloader Adjustment

IDLE and MIXTURE ADJUSTMENT

1. Thoroughly warm up engine. If engine is cold, allow to run for at least 15 minutes.
2. Inspect torque of carburetor to manifold bolts and manifold-to-cylinder head bolts to exclude possibility of air leaks.
3. Adjust idle speed to 650 RPM, as indicated on tachometer. (Figure 13)
4. Adjust idle mixture screw until smooth slow speed performance is obtained.

CAUTION: Do not bottom idle mixture screw with force. Refer to Figure 13.

Regardless of altitude of climatic conditions, secure a proper idle adjustment by following the above procedure.

CHOKE UNLOADER ADJUSTMENT

1. Place throttle valve in wide open position and insert shank of 7/64" (2.78mm) drill (.110 [2.8mm] plus-or-minus .003" [.08mm]) between upper edge of choke valve and inner wall of air horn. (Figure 15)
2. Adjust clearance by bending "tang" on throttle lever up to open or down to close. (Figure 16)

CHOKE SETTING

1. Check choke valve so that it does not bind or stick.
2. Set choke index lean at the last notch. (Figure 11)

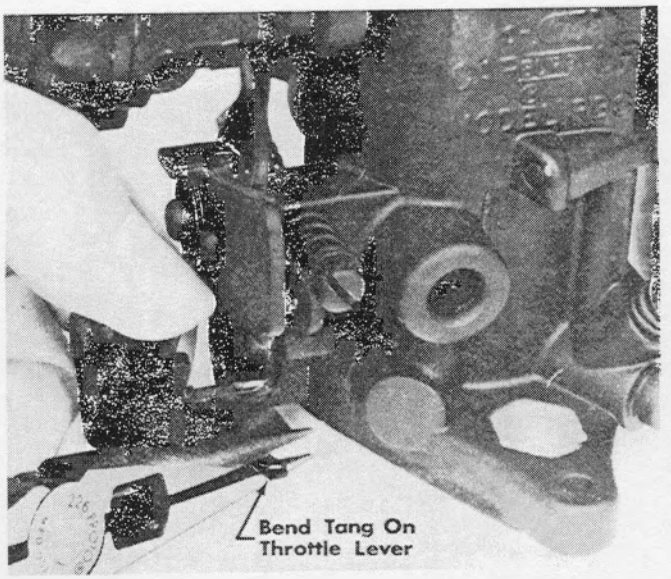


Figure 16. Bending Tang

MODEL 4MV QUADRAJET CARBURETOR

DESCRIPTION

The model 4MV Quadrajet is a 4-barrel, 2-stage carburetor. (Figure 1)

The Quadrajet carburetor has 2 stages in operation. The primary (fuel inlet) side has small bores with a triple venturi set-up equipped with plain tube nozzles. Its metering principles are similar to most plain tube carburetors which use the venturi principle. The triple venturi stack up, plus smaller primary bores, give a more stable and finer fuel control in idle and economy ranges of operation. Fuel metering in primary side is accomplished with tapered metering rods positioned by a manifold vacuum responsive piston.

Secondary side has 2 very large bores which have greatly increased air capacity to meet present day and future automotive engine demands. Air valve principle is used in secondary side for metering control and supplements fuel flow from primary bores.

Using air valve principle, fuel is metered in direct proportion to air passing thru secondary bores.

Fuel reservoir is centrally located to avoid problems of fuel slosh causing engine turn cut-out and delayed fuel to carburetor bores. Float system uses a single float pontoon for ease in servicing the unit.

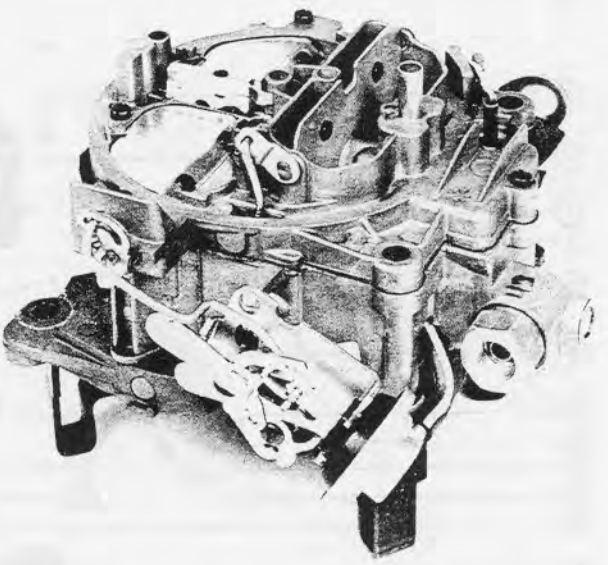


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Figure 1. 4MV Quadradjet Carburetor

PRECAUTIONS

Before making carburetor adjustments, be sure that carburetor-to-manifold head bolts are tight to prevent air leaks. Warm up engine to operating temperature, or carburetor misalignment will occur. Allow engine to run for at least 15 minutes.

NOTE: Fast idle cam lever adjusting screw and spring have not been removed from some quadrajet carburetors installed on a number of MerCruiser Marine 225, 250 and 325 Stern Drive and Inboard Engines, Serial No. 2404127 and below. These engines automatically will run at fast idle immediately following a cold-engine start and continue to do so until automatic choke has opened to point where fast idle cam lever drops off the cam. This condition is not normal and is not required in marine applications. If this spring and screw are found in any quadrajet carburetors (on engines specified above), remove and discard. It may be necessary to readjust throttle cable and idle stop screw to obtain 550-600 RPM idle after screw and spring are removed. If fuel inlet filter, located inside quadrajet carburetors used on MerCruiser engines with Serial No. 2314316 and below, does not allow sufficient fuel flow and causes erratic engine operation, replace with new filter (B-35-53386). MerCruiser engines with quadrajet carburetors and between Serial Nos. 2314317 and 2494935 do not have fuel inlet filter installed in carburetor. When servicing these engines, install new filter (B-35-53386) and spring (B-24-48143). MerCruiser engines, Serial No. 2494936 and above, which are equipped with a quadrajet carburetor, have new filter installed.

TROUBLESHOOTING

Refer to troubleshooting chart in the "B" and "BC" section, preceding.

NOTE: Refer to "Specifications" Section 8 for current specifications.

REMOVAL

1. Remove flame arrestor.
2. Disconnect fuel line.
3. Disconnect throttle linkage.
4. Disconnect choke coil rod (only applies to carburetors with thermostatic choke).
5. Remove choke solenoid and linkage (only applies to carburetors with electric choke).
6. Remove fasteners which fasten carburetor to intake manifold and remove carburetor from manifold.
7. Remove and discard carburetor to manifold gasket.

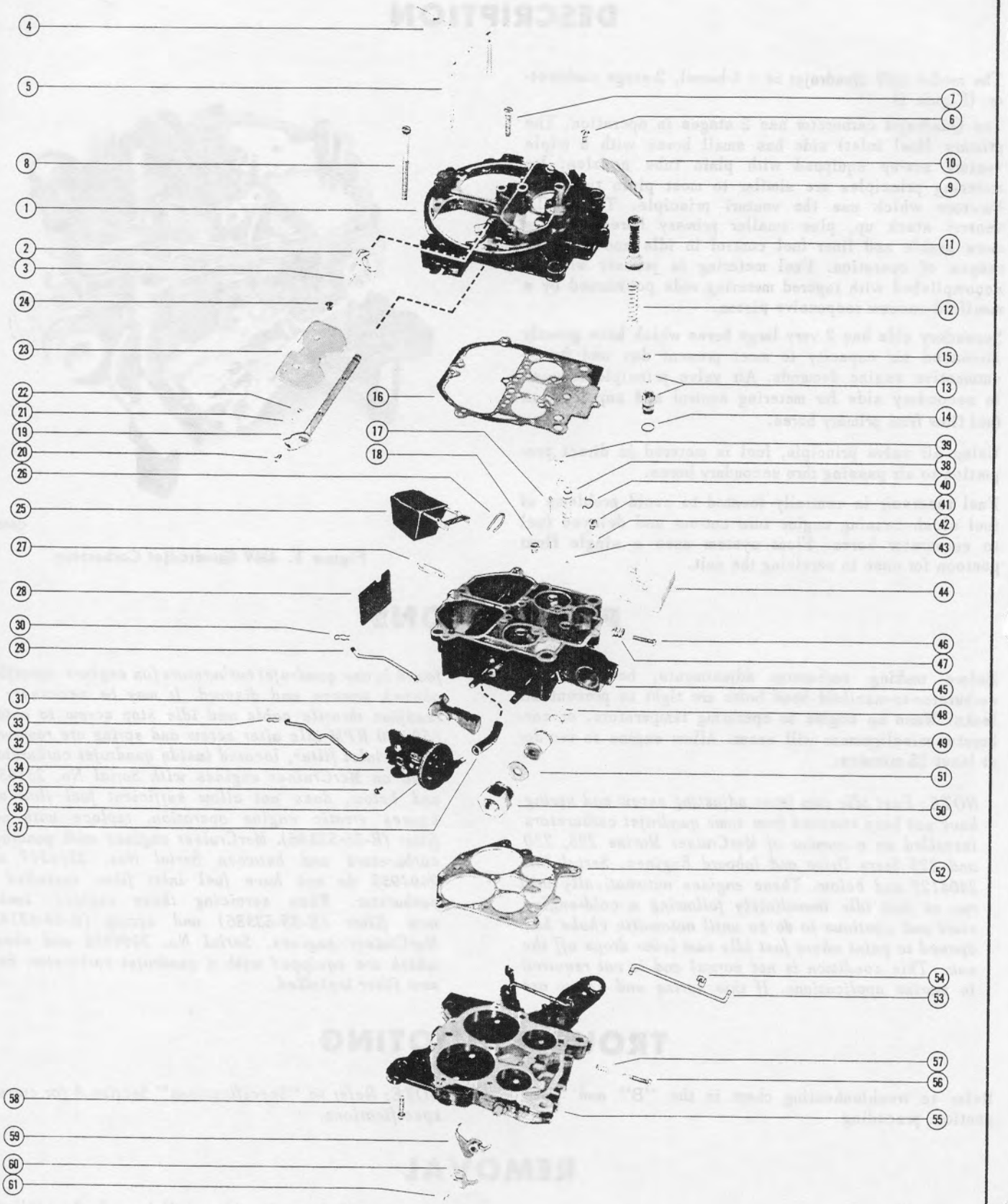


Figure 2. 4MV Quadrajet Carburetor Exploded View

1 Air Horn Assembly
2 Lever, air valve lockout
3 Roll Pin, lockout lever
4 Holder Kit, secondary metering rod
5 Metering Rod, secondary
6 Screw
7 Screw
8 Screw
9 Lever, actuating - pump
10 Roll Pin, hinge - pump lever
11 Pump Assembly
12 Spring, pump return
13 Needle and Seat Assembly
14 Gasket, needle and seat
15 Pull Clip, float needle
16 Gasket, air horn
17 Metering Rod, primary
18 Jet, primary
19 Choke Shaft and Lever Assembly
20 Screw, choke lever attaching
21 Lockwasher, choke lever screw
22 Nut, choke lever screw
23 Valve, choke - choke shaft
24. Screw, choke valve to choke shaft
25 Float Assembly
26 Pin, hinge - float
27 Lever, intermediate choke
28 Baffle, float bowl
29 Rod, choke
30 Clip, choke rod
31 Cam, fast idle
32 Rod, vacuum control
33 Clip, vacuum control rod
34 Bracket Assembly, vacuum control
35 Screw, vacuum control bracket to float bowl
36 Control Assembly, vacuum
37 Hose, vacuum
38 Power Piston Assembly
39 Spring, metering rod - primary
40 Retainer, power piston
41 Retainer, pump discharge ball
42 Ball, pump discharge
43 Spring, power piston
44 Insert, float bowl
45 Float Bowl Assembly
46 Screw, idle stop
47 Spring, idle stop screw
48 Spring, filter nut
49 Filter, fuel inlet
50 Nut, filter - fuel inlet
51 Gasket, filter nut
52 Gasket, throttle body
53 Rod, pump
54 Clip, pump rod
55 Throttle Body Assembly
56 Idle Needle, throttle body
57 Spring, idle needle
58 Screw, throttle body to float bowl
59 Lever, cam
60 Lever, fast idle
61 Screw, lever and cam to throttle body

(Legend for Figure 2)

AIR HORN REMOVAL

1. Mount carburetor on suitable holding fixture.
2. Remove clips from upper end of choke rod. Disconnect choke rod from upper choke shaft lever and remove choke rod from bowl. (Figure 3)
3. Remove spring clip from upper end of pump rod and disconnect pump rod from pump lever. (Figure 3)
4. Remove 9 air horn to bowl attaching screws (4 long screws, 3 short screws and 2 counter-sunk screws). (Figure 3) Two attaching screws are located next to primary venturi.
5. Remove air horn by lifting straight up. Air horn gasket should remain on bowl for removal later.

CAUTION: Care must be taken not to bend 2 small main well air bleed tubes protruding from air horn. These are permanently pressed into casting. DO NOT REMOVE.

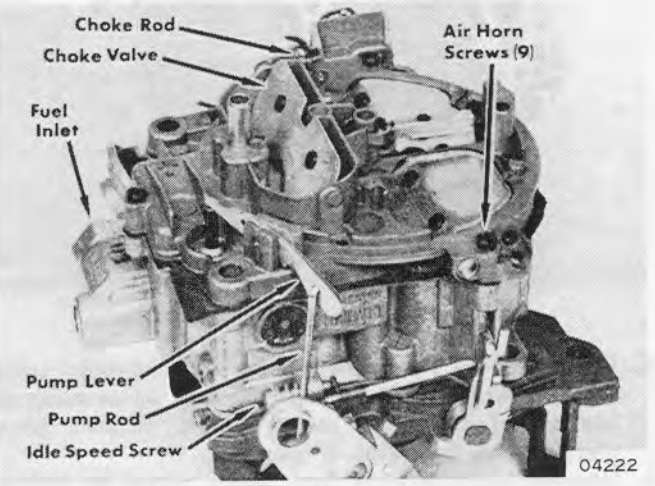


Figure 3. Removing Air Horn

DISASSEMBLY

AIR HORN DISASSEMBLY

1. Remove secondary metering rods by holding air valve wide open, then tilt and slide rods from holes in hanger. (Figure 4)

   NOTE: Further disassembly of air horn is not required for cleaning purposes. If part replacement is required, proceed as follows:

2. Remove choke valve attaching screws, then remove choke valve and shaft.
3. Remove pump lever roll pin, then pump lever.

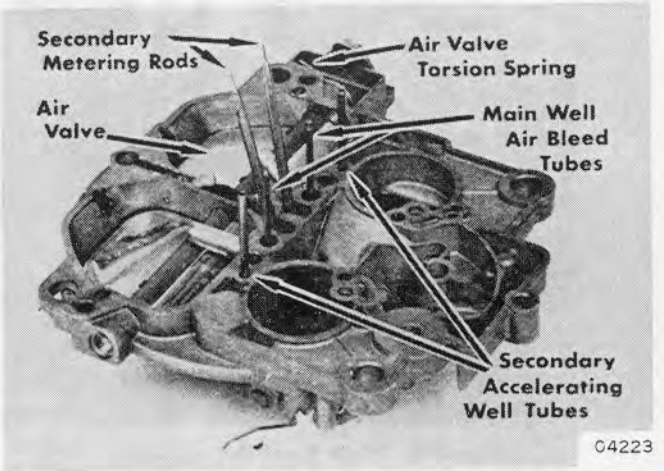


Figure 4. Air Horn Disassembly

CAUTION: Air valves, air valve shaft and secondary metering rod hangers are calibrated and should not be removed.

FLOAT BOWL DISASSEMBLY

1. Remove pump plunger from pump well.
2. Remove air horn gasket from dowels on secondary side of bowl, then remove gasket from around power piston and primary metering rods.
3. Remove pump return spring from pump well. (Figure 5)
4. Remove plastic filler over float valve. (Figure 5)

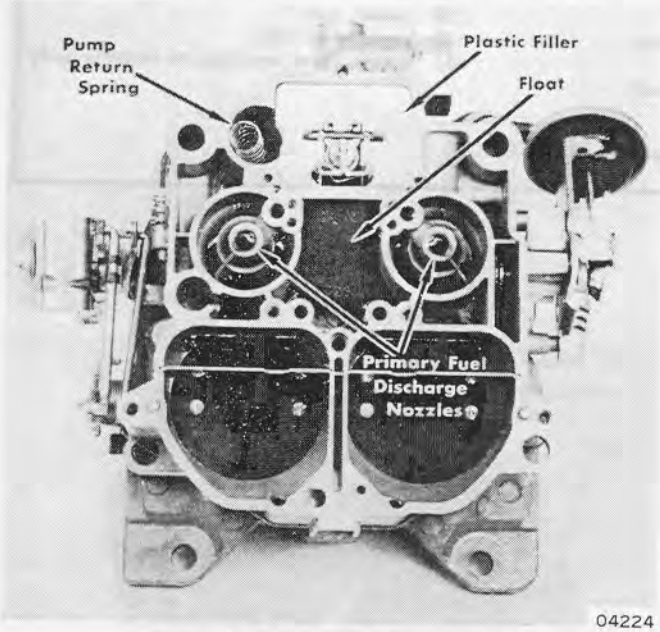


Figure 5. Float Bowl Disassembly

5. Remove power piston and primary metering rods, using needle-nosed pliers to pull straight up on metering rod hanger directly over power piston. Remove power piston spring from well. (Figure 6)
6. Remove metering rods from power piston by disconnecting tension spring from top of each rod, then rotating rod to remove from hanger.
7. Remove float assembly by pulling up slightly on retaining pin until pin can be removed by sliding toward pump well. Lift float and inlet needle up out of float bowl.

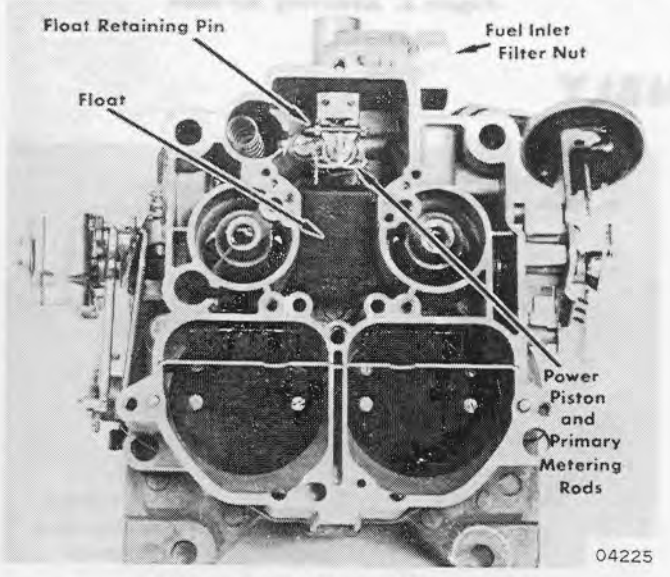


Figure 6. Float Bowl Disassembly

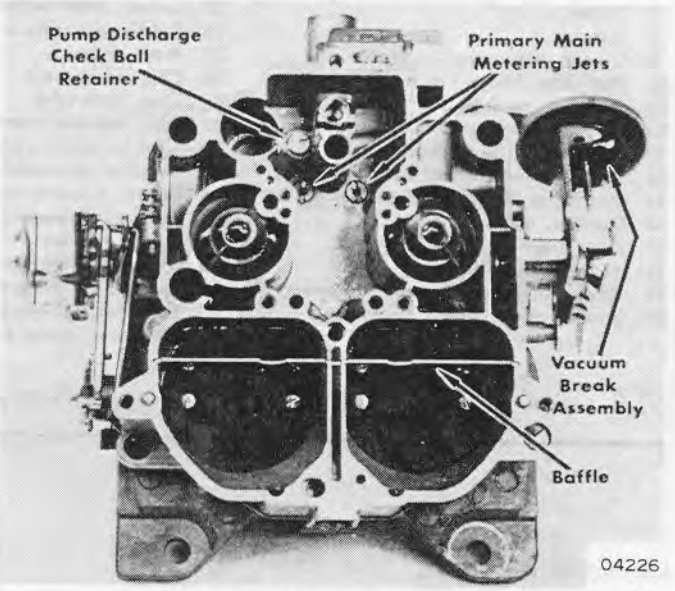


Figure 7. Float Bowl Disassembly

8. Remove pull clip from float arm and inlet needle, being careful not to distort clip.
9. Remove fuel inlet needle seat from float bowl with a wide blade screwdriver. Remove gasket from seat.
10. Remove primary metering jets. DO NOT remove secondary metering plates. (Figure 7)
11. Remove pump discharge check ball retainer and check ball. (Figure 7)
12. Remove baffle from secondary side of bowl. (Figure 7)
13. Remove vacuum hose from vacuum break assembly and from tube connection on bowl. (Figure 7)
14. Remove retaining screw from choke assembly and remove assembly from float bowl.

NOTE: If further disassembly of choke is necessary, remove clip from vacuum break link at vacuum break lever, then remove rod from vacuum break lever. Spread retaining ears on bracket next to vacuum break assembly, then remove vacuum break assembly from lever.

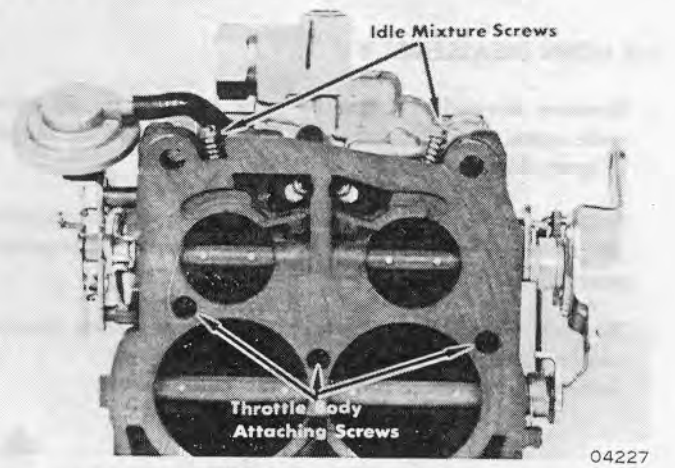


Figure 8. Throttle Body Attaching Screws

15. Remove fast idle cam from choke assembly.
16. Remove lower choke rod and actuating lever from float bowl well.
17. Remove fuel inlet filter nut, gasket, filter and spring.
18. Remove screws which fasten throttle body to float bowl. (Figure 8) Separate pieces and remove bowl to body insulator gasket.

THROTTLE BODY DISASSEMBLY

1. Rotate pump rod and remove rod from primary throttle lever.
2. Remove idle mixture screws and springs.

IMPORTANT: Further disassembly of throttle body is not required. Extreme care must be taken to avoid damaging secondary throttle valves.

CLEANING and INSPECTION

1. Clean carburetor in a cold immersion-type cleaner, such as Carbon- X (X-55) or equivalent.

CAUTION: Any rubber parts, plastic parts, diaphragms and pump plungers should not be immersed in carburetor cleaner. The delrin cam on air valve shaft, however, will withstand normal cleaning in carburetor cleaner.

2. Blow out all passages in castings with compressed air. Do not pass drills thru jets or passages.
3. Inspect idle mixture needles for damage.
4. Examine float needle and seat for wear. If worn, replace with new inlet needle and seat assembly.
5. Inspect upper and lower surfaces of carburetor castings for damage.
6. Inspect holes in levers for excessive wear or out-of-round condition. If worn, replace levers.
7. Examine fast idle cam for wear or damage.
8. Check air valve for binding condition. If air valve is damaged, replace air horn assembly.
9. Check all throttle levers and valves for binds or other damage.

REASSEMBLY

THROTTLE BODY REASSEMBLY

1. Install idle mixture needles and springs until seated. Back out needles 2 turns as a preliminary idle adjustment.
2. Install pump rod in lower hole of throttle lever by rotating rod.

FLOAT BOWL REASSEMBLY

1. Install new throttle body to bowl insulator gasket. Be certain that gasket is properly installed over 2 locating dowels on bowl.
2. Install throttle body. Be sure that throttle body is properly located over dowels on float bowl, then install throttle body to bowl screws and tighten evenly and securely. Place carburetor on proper holding fixture.
3. Install fuel inlet filter, new gasket and inlet nut and tighten nut securely.

NOTE: If vacuum break diaphragm was removed from bracket, slide vacuum break diaphragm between retaining ears to hold securely. Install vacuum break rod (U-bend end) in diaphragm link with end toward bracket, then install grooved end of rod in hole of actuating lever and retain to vacuum break lever with spring clip.

4. Install fast idle cam on vacuum break assembly. Be sure that fast idle cam pick-up lever on intermediate choke shaft is located in cut-out area of fast idle cam.
5. Connect choke rod to choke rod actuating lever (plain end). Hold choke rod (with grooved end pointing inward) and position choke rod actuating lever in well of float bowl. Install choke assembly, engaging shaft with hole in actuating lever. Install retaining screw and tighten securely. Remove choke rod from lever for installation later.
6. Install vacuum hose to tube connection on bowl and vacuum break assembly.
7. Install air deflector in secondary side of bowl with notches toward top.
8. Install pump discharge check ball and retainer in passage next to pump well.
9. Install primary main metering jets.
10. Install fuel inlet needle seat and gasket. Use wide blade screwdriver to avoid distortion. Place inlet needle in position in seat.
11. Using needlenose pliers to hole needle pull clip, install pull clip on needle. Pull clip is properly positioned with open end toward front of bowl.
12. Install float by sliding float lever under pull clip from front to back. With float lever in pull clip, hold float assembly at toe and install retaining pin from pump well side. Be carefull not to distort pull clip.
13. Adjust float level as outlined under "Adjustments", following.
14. Install power piston spring in power piston well. If primary main metering rods were removed from hanger, reinstall and make sure that tension spring is connected to top of each metering rod. Install power piston assembly in well with metering rods properly positioned in metering jets. Press down firmly on power piston to ensure engagement of retaining clip.
15. Install plastic filler over float needle, pressing downward until seated properly.
16. Install pump return spring in pump well.
17. Install air horn gasket around primary metering rods and

piston. Position gasket over 2 dowels on secondary side of bowl.
18. Install pump plunger in pump well.

AIR HORN REASSEMBLY

1. Install the following, if removed: Pump lever and retain with roll pin, choke shaft, choke valve and 2 attaching screws.
2. Install secondary metering rods. With air valve held wide open, rods should be positioned with upper ends thru hanger holes and toward each other.

AIR HORN to BOWL INSTALLATION

1. Carefully place air horn assembly on bowl, positioning secondary metering rods, vent tubes and accelerating well tubes thru air horn gasket. When installing, be certain that pump plunger is positioned properly thru air horn. To prevent distortion of secondary metering plates, do not force air horn assembly onto float bowl. A slight sideward movement will center metering rods in metering plates.
2. Install 4 long air horn screws around secondary side, 2 short screws in center section and one short screw above fuel inlet. Two counter-sunk screws are installed in primary venturi area. Tighten all screws evenly and securely. (Figure 9)
3. Connect pump rod to pump lever and retain with spring clip.
4. Connect choke rod to lower choke lever and upper choke lever. Install spring clip on upper end of rod.

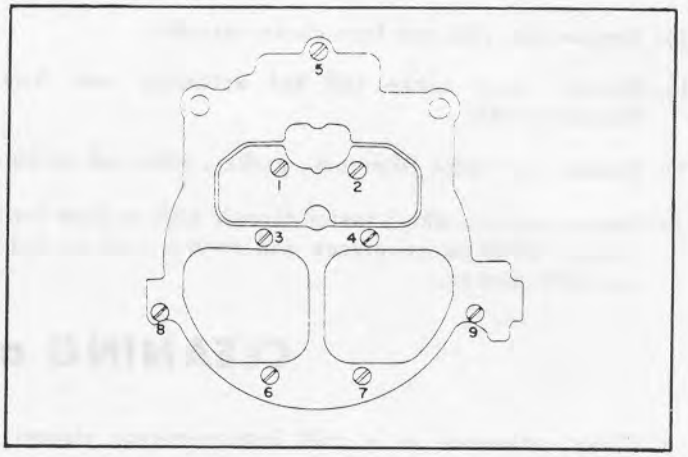


Figure 9. Quadrajet Air Horn Screw Tightening Sequence

5. Connect vacuum break link rod to air valve lever and vacuum break stem. Install spring slip in groove on vacuum break end of link rod.
6. Check following adjustments as outlined:
   a. Pump adjustment.
   b. Choke rod adjustment.
   c. Air valve dashpot adjustment.
   d. Vacuum break adjustment.
   e. Unloader adjustment.
   f. Air valve lockout adjustment.
   g. Secondary opening adjustment.
   h. Secondary closing adjustment.
   i. Secondary metering rod adjustment.
   j. Air valve spring adjustment.

INSTALLATION

1. Place baffle plate and new base gasket in position on intake manifold.
2. Fasten carburetor to manifold, using fasteners which were removed previously.
3. Connect throttle linkage.
4. Connect fuel line.
5. Adjust choke.
6. Install flame arrestor.
7. Adjust idle speed and mixture.

ADJUSTMENTS

Following adjustments can be completed with carburetor installed on engine. Make adjustments in sequence listed. Adjustment specifications follow.

FLOAT LEVEL (Figure 10)

1. Remove flame arrestor from carburetor.
2. Remove air horn from float bowl as outlined under "Disassembly", preceding.
3. Measure from top of float bowl gasket surface (gasket removed) to top of float at toe (locate gauging point 1/16" [1.6mm] back from toe). Do not gauge on numbers on float.

   NOTE: Make sure that retaining pin is held firmly in place and that float tang is seated on float needle.

4. Bend float arm up or down, as required, to obtain dimension specified.
5. Reinstall air horn as outlined under "Air Horn to Bowl Installation".

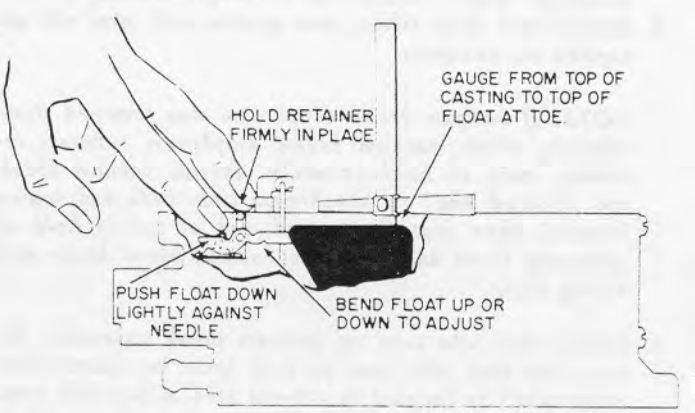


Figure 10. Float Level Adjustment

PUMP ADJUSTMENT (Figure 11)

1. Disconnect secondary actuating link.
2. With throttle valves completely closed and pump rod in specified hole in lever, measure from top of choke valve wall (next to vent stack) to top of pump stem.
3. Bend pump lever to obtain dimension specified.
4. Connect actuating link.

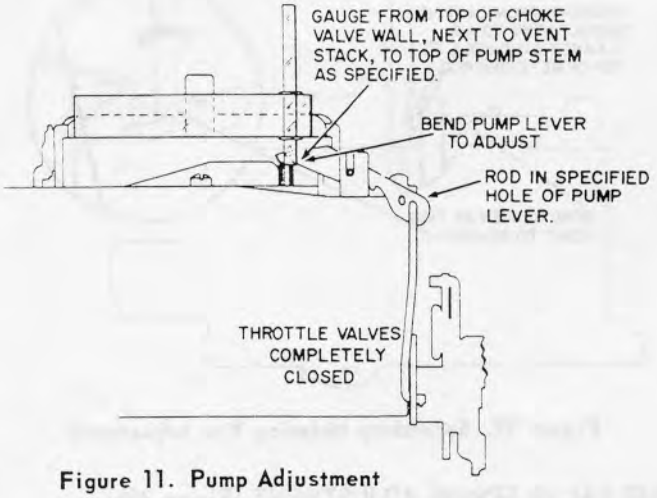


Figure 11. Pump Adjustment

CHOKE ROD ADJUSTMENT (Figure 12)

1. Place cam follower on second step of fast idle cam and against high step. Rotate choke valve toward closed position by pushing down lightly on vacuum break lever.
2. Dimension between lower edge of choke valve and air horn wall should be as specified. Bend choke rod to adjust.

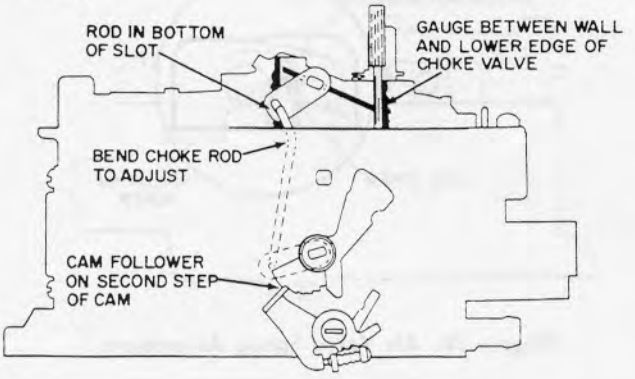


Figure 12. Choke Rod Adjustment

AIR VALVE DASHPOT ADJUSTMENT (Figure 13)

Push vacuum break stem in until diaphragm is seated. Clearance, as specified, must exist between dashpot rod and end of slot in air valve lever. Bend rod at air valve end to adjust.

VACUUM BREAK ADJUSTMENT (Figure 14)

1. Push vacuum break stem in until diaphragm is seated and hold choke valve toward closed position.

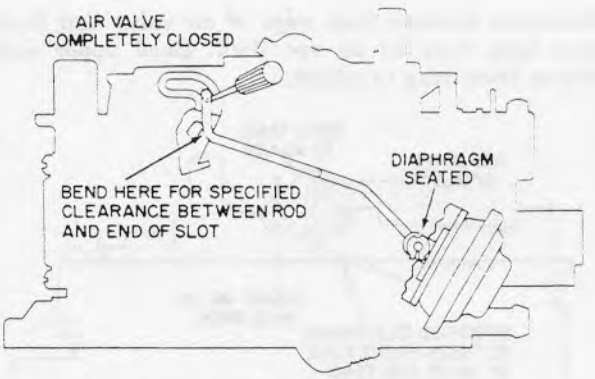


Figure 13. Air Valve Dashpot Adjustment

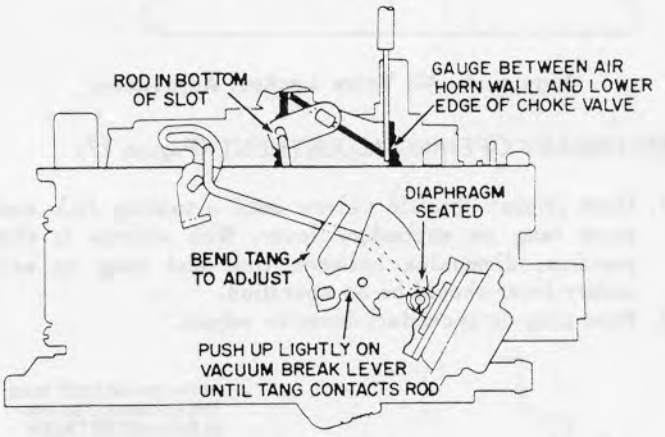


Figure 14. Vacuum Break Adjustment

2. Dimension between lower edge of choke valve and air horn wall should be as specified. Bend vacuum break tang to adjust.

UNLOADER ADJUSTMENT (Figure 15)

1. With choke valve held in closed position by a rubber band on vacuum break lever, open primary throttle valves to wide open position.
2. Dimension between edge of choke valve and air horn wall should be as specified. Bend fast idle lever tang to adjust.

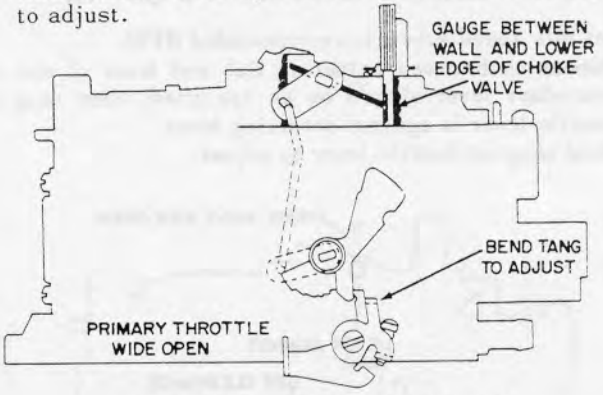


Figure 15. Unloader Adjustment

AIR VALVE LOCKOUT ADJUSTMENT (Figure 16)

1. Open choke valve to wide open position by rotating vacuum break lever. Choke rod must be to top of slot in choke lever.

2. Dimension between front edge of air valve and lockout lever tang must be as specified. Bend upper end of lockout lever tang to adjust.

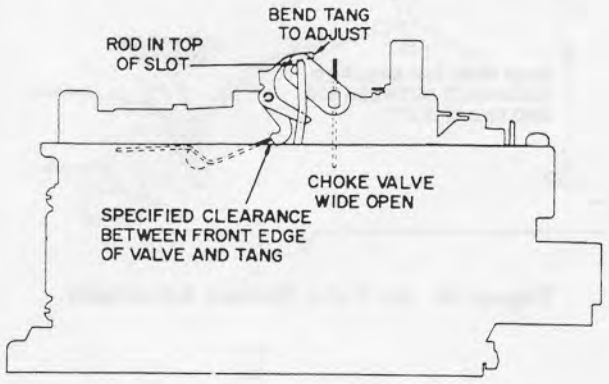


Figure 16. Air Valve Lockout Adjustment

SECONDARY OPENING ADJUSTMENT (Figure 17)

1. Open primary throttle valves until actuating link contacts tang on secondary lever. With valves in this position, dimension between link and tang on secondary lever should be as specified.
2. Bend tang on secondary lever to adjust.

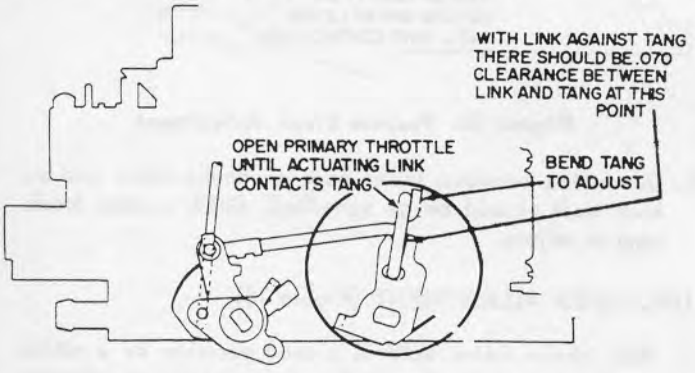
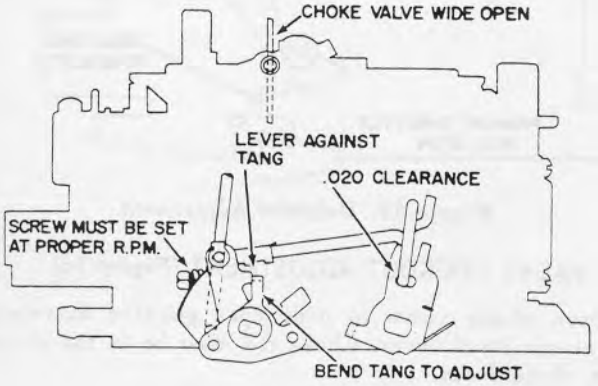


Figure 17. Secondary Opening Adjustment

SECONDARY CLOSING ADJUSTMENT (Figure 18)

1. Set idle speed screw to recommended RPM.
2. Dimension between actuating link and front of slot in secondary lever should be as specified when tang on throttle lever is against actuating lever.
3. Bend tang on throttle lever to adjust.



SECONDARY METERING ROD ADJUSTMENT (Figure 19)

1. Measure from top of metering rod to top of air horn casting next to flame arrestor stud hole. Dimension must be as specified.
2. To adjust, bend metering rod hanger at point shown. Both rods must be adjusted to same dimension.

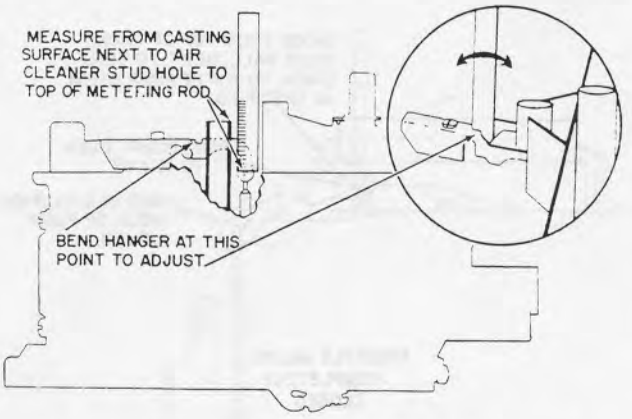


Figure 19. Secondary Metering Rod Adjustment

AIR VALVE SPRING ADJUSTMENT (Figure 20)

1. Loosen allen head lockscrew and turn adjusting screw counterclockwise to remove all spring tension.
2. With air valve closed, turn adjusting screw clockwise number of turns which are specified after torsion spring contacts pin on shaft. Hold adjusting screw in this position and tighten lockscrew.

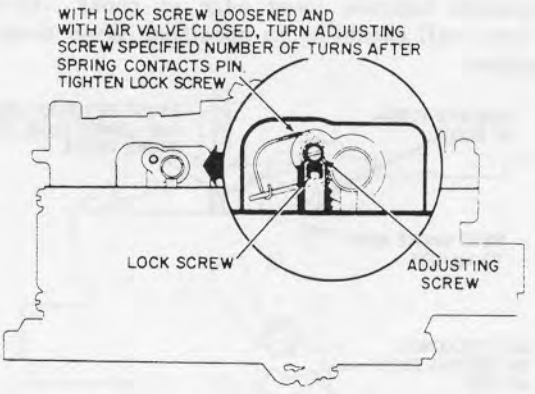


Figure 20. Air Valve Spring Adjustment

CHOKE ADJUSTMENT

Carburetors equipped with electric choke do not require any adjustment.

CHOKE COIL ROD ADJUSTMENT - 225 and 250 Engines (Figure 21)

1. With choke valve completely closed and choke rod at bottom of choke lever slot, push choke coil rod down to end of travel.

Figure 18. Secondary Closing Adjustment

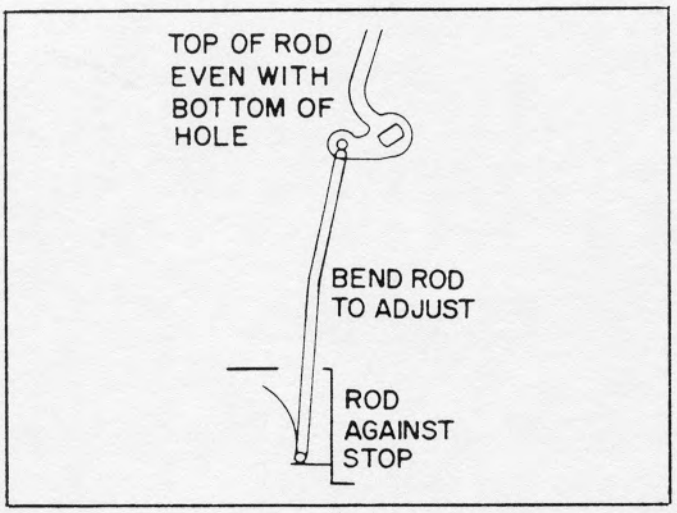


Figure 21. Choke Coil Rod Adjustment
225 and 250 Engines

2. Rod should be positioned as shown. Bend choke coil rod to adjust.

CHOKE COIL ROD ADJUSTMENT - 325 Engine (Figure 22)

1. With choke valve completely closed and choke rod at bottom of choke lever slot, pull choke coil rod up to end of travel.
2. Rod should be positioned as shown. Bend choke coil rod to adjust.

IDLE SPEED AND MIXTURE ADJUSTMENTS

NOTE: Flame arrestor must be installed.

1. Connect service tachometer to engine.
2. Start engine and allow to run until normal operating temperature is reached and choke is fully open.
3. Disconnect throttle cable from engine.
4. Adjust idle speed screw to obtain 550-600 RPM on tachometer.
5. Adjust each idle mixture screw separately to give peak RPM indications on tachometer.
6. Re-adjust idle speed screw to obtain 550-600 RPM with unit in forward gear.
7. Stop engine and remove tachometer.
8. Connect throttle cable.

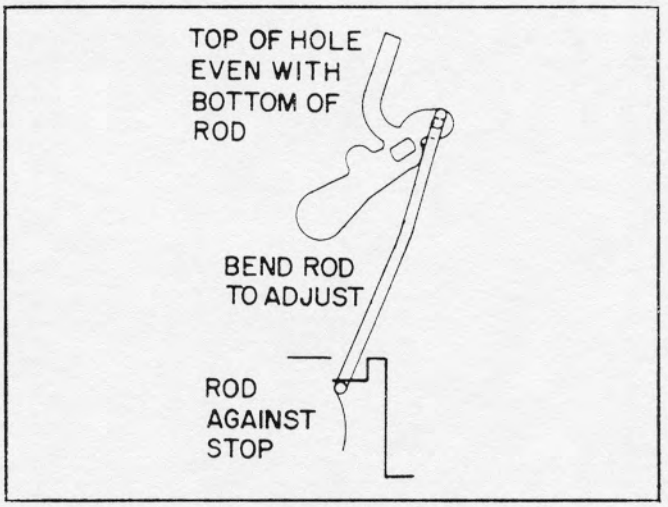


Figure 22. Choke Coil Rod Adjustment - 325 Engine

TOP OF ROD
EVEN WITH
BOTTOM OF
HOLE
BEND ROD
TO ADJUST
ROD
AGAINST
STOP

TOP OF HOLE
EVEN WITH
BOTTOM OF
ROD
BEND ROD
TO ADJUST
ROD
AGAINST
STOP

HOLLEY MODEL 2300-C CARBURETOR

DESCRIPTION

The Holley 2300-C is a 2 venturi downdraft carburetor. Both venturis include a booster venturi and a main discharge nozzle built into the booster venturi. The carburetor utilizes 4 metering systems: Idle system, main metering system, power enrichment system and accelerator pump system. It also includes a float system and choke system.

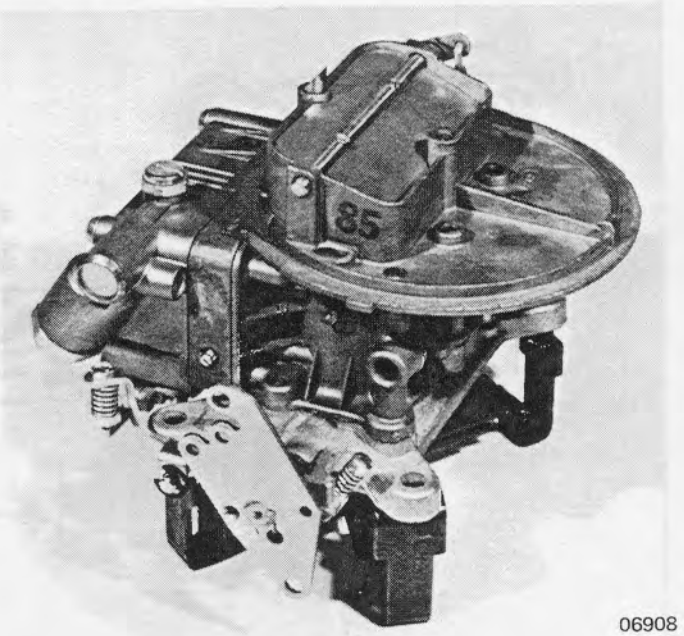


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Figure 1. Holley Model 2300-C Carburetor

PRECAUTIONS

Before making carburetor adjustments, be sure that carburetor-to-manifold and manifold-to-cylinder head bolts are tight to prevent air leaks. Carburetor misadjustment will occur if engine is not warmed to operating temperature prior to making adjustments. Allow engine to run at least 15 minutes.

TROUBLESHOOTING

Refer to troubleshooting chart in "B" and "BC" carburetor section, preceding.

NOTE: Refer to "Specifications" Section 8 for current specifications.

REMOVAL

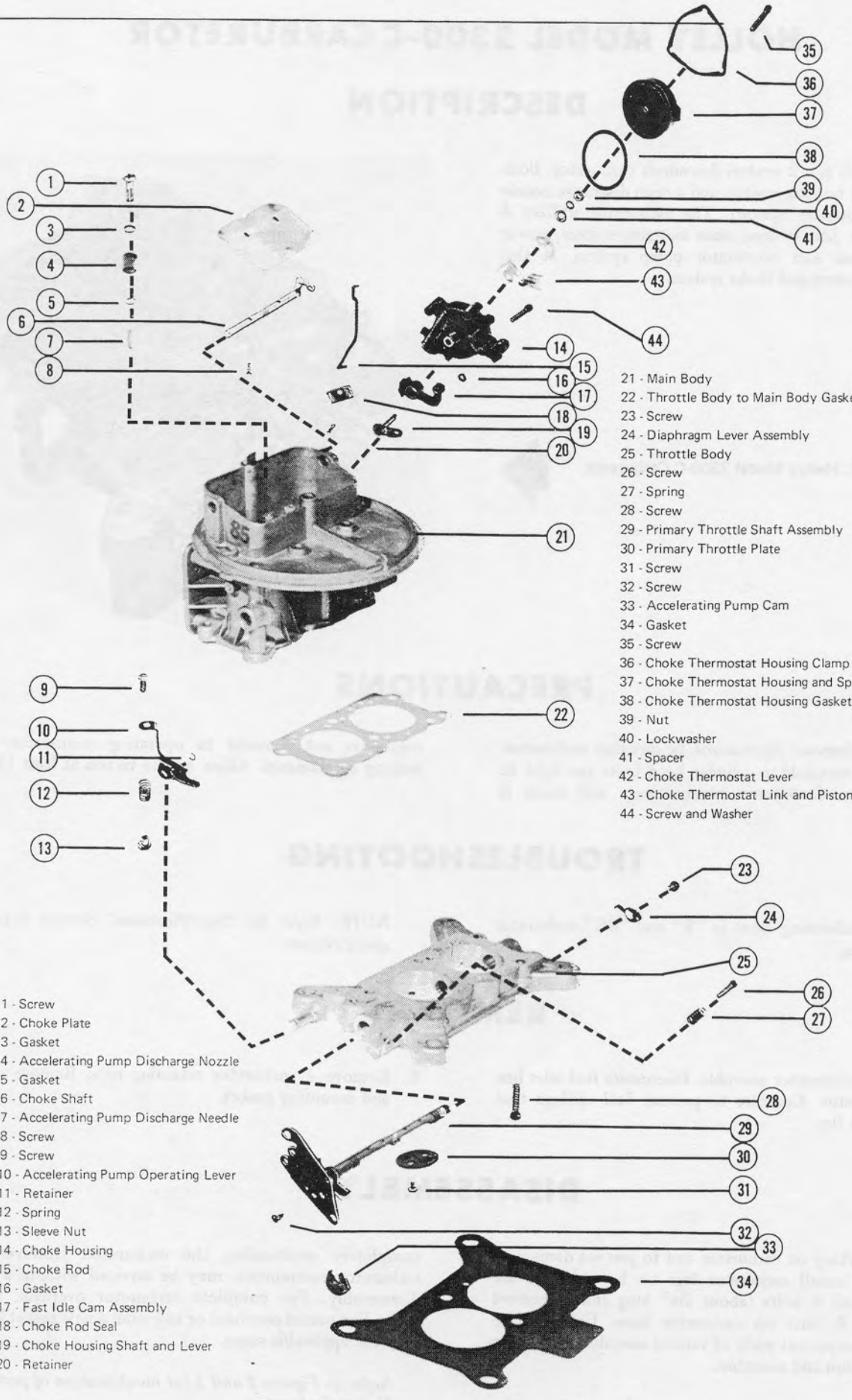
1. Remove flame arrestor assembly. Disconnect fuel inlet line from carburetor. Use care to prevent fuel spillage that could cause a fire.
2. Remove 4 carburetor retaining nuts. Remove carburetor and mounting gasket.

DISASSEMBLY

To facilitate working on carburetor and to prevent damage to throttle plates, install carburetor legs on base. If legs are unavailable, install 4 bolts (about 2¼" long and of correct diameter) and 8 nuts on carburetor base. Use separate container for component parts of various assemblies for easier cleaning, inspection and assembly.

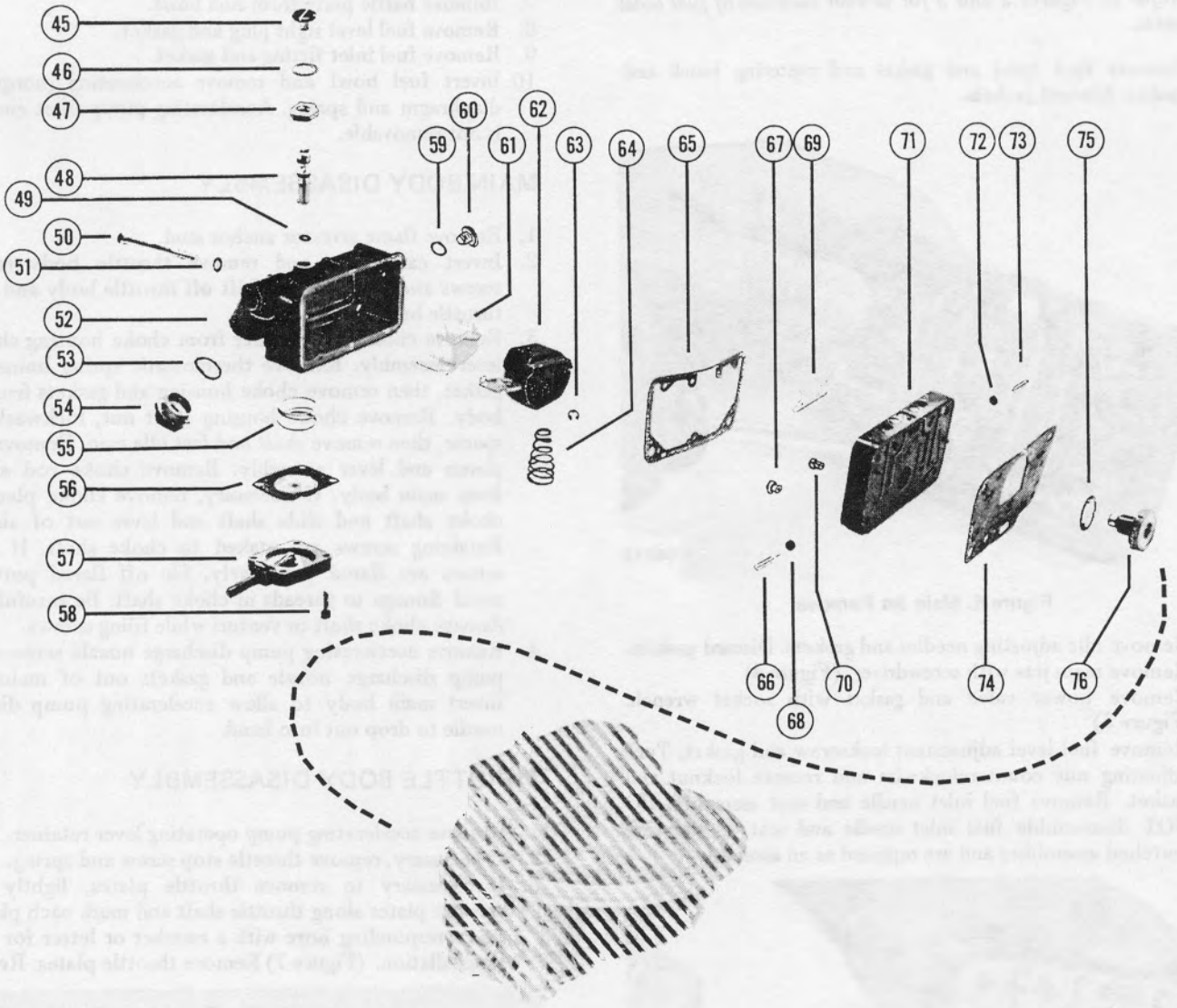
Following is a step-by-step sequence of operations for completely overhauling the carburetor. However, certain carburetor components may be serviced without a complete disassembly. For complete carburetor overhaul, follow all steps. For partial overhaul or to install a new gasket kit, follow only the applicable steps.

Refer to Figures 2 and 3 for identification of parts used on Holley Carburetor.



1 - Screw
2 - Choke Plate
3 - Gasket
4 - Accelerating Pump Discharge Nozzle
5 - Gasket
6 - Choke Shaft
7 - Accelerating Pump Discharge Needle
8 - Screw
9 - Screw
10 - Accelerating Pump Operating Lever
11 - Retainer
12 - Spring
13 - Sleeve Nut
14 - Choke Housing
15 - Choke Rod
16 - Gasket
17 - Fast Idle Cam Assembly
18 - Choke Rod Seal
19 - Choke Housing Shaft and Lever
20 - Retainer
21 - Main Body
22 - Throttle Body to Main Body Gasket
23 - Screw
24 - Diaphragm Lever Assembly
25 - Throttle Body
26 - Screw
27 - Spring
28 - Screw
29 - Primary Throttle Shaft Assembly
30 - Primary Throttle Plate
31 - Screw
32 - Screw
33 - Accelerating Pump Cam
34 - Gasket
35 - Screw
36 - Choke Thermostat Housing Clamp
37 - Choke Thermostat Housing and Spring
38 - Choke Thermostat Housing Gasket
39 - Nut
40 - Lockwasher
41 - Spacer
42 - Choke Thermostat Lever
43 - Choke Thermostat Link and Piston Assembly
44 - Screw and Washer

Figure 2. Holley Carburetor Model 2300-C Exploded View



45 - Lockscrew
46 - Gasket
47 - Fuel Level Adjusting Nut
48 - Fuel Inlet Needle and Seat
49 - "O" Ring Seal
50 - Screw
51 - Gasket
52 - Primary Fuel Bowl
53 - Gasket
54 - Fuel Inlet Fitting
55 - Diaphragm Spring
56 - Diaphragm Assembly
57 - Accelerating Pump Cover
58 - Retaining Screw and Lockwasher
59 - Gasket
60 - Fuel Level Sight Plug
61 - Baffle Plate
62 - Float
63 - Retainer
64 - Float Spring
65 - Primary Fuel Bowl Gasket
66 - Idle Adjusting Needle
67 - Main Jet
68 - Seal
69 - Baffle Plate
70 - Main Jet
71 - Primary Metering Block
72 - Seal
73 - Idle Adjusting Needle
74 - Primary Metering Block Gasket
75 - Power Valve Gasket
76 - Power Valve

Figure 3. Holley Carburetor - Exploded View (Continued)

FUEL BOWL and METERING BLOCK DISASSEMBLY

Refer to Figures 2 and 3 for correct location of fuel bowl parts.

1. Remove fuel bowl and gasket and metering block and gasket. Discard gaskets.

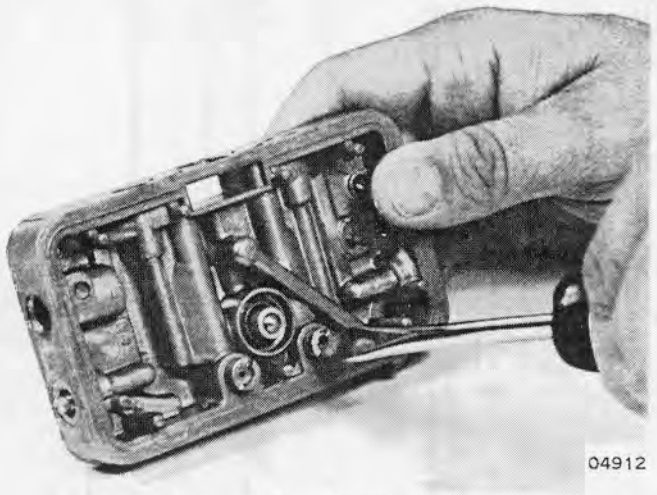


Figure 4. Main Jet Removal

2. Remove idle adjusting needles and gaskets. Discard gaskets.
3. Remove main jets with screwdriver. (Figure 4)
4. Remove power valve and gasket with socket wrench. (Figure 5)
5. Remove fuel level adjustment lockscrew and gasket. Turn adjusting nut counterclockwise and remove locknut and gasket. Remove fuel inlet needle and seat assembly. DO NOT disassemble fuel inlet needle and seat, as they are matched assemblies and are replaced as an assembly.

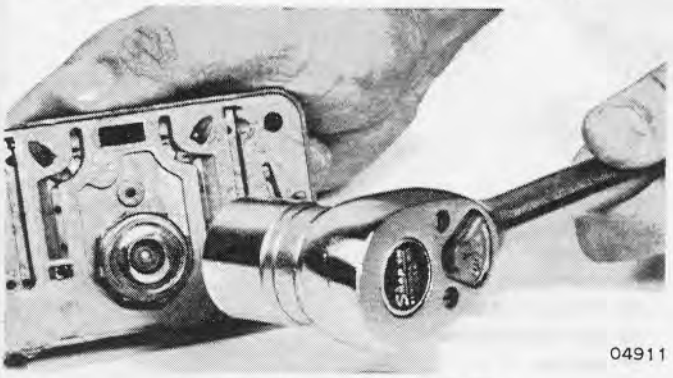


Figure 5. Power Valve Removal

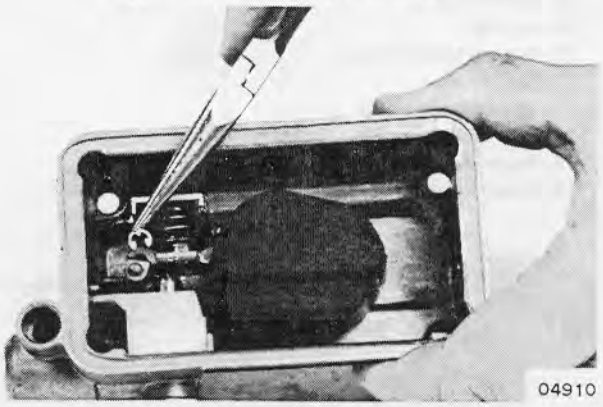


Figure 6. Float Shaft Retainer Removal

6. Remove float retainer with needle-nose pliers. (Figure 6) Slide float off shaft. Remove spring from float.
7. Remove baffle plate from fuel bowl.
8. Remove fuel level sight plug and gasket.
9. Remove fuel inlet fitting and gasket.
10. Invert fuel bowl and remove accelerating pump cover, diaphragm and spring. Accelerating pump inlet check ball is not removable.

MAIN BODY DISASSEMBLY

1. Remove flame arrestor anchor stud.
2. Invert carburetor and remove throttle body retaining screws and lockwashers. Lift off throttle body and discard throttle body gasket.
3. Remove choke rod retainer from choke housing shaft and lever assembly. Remove thermostatic spring housing and gasket, then remove choke housing and gaskets from main body. Remove choke housing shaft nut, lockwasher and spacer, then remove shaft and fast idle cam. Remove choke piston and lever assembly. Remove choke rod and seal from main body. If necessary, remove choke plate from choke shaft and slide shaft and lever out of air horn. Retaining screws are staked to choke shaft. If tips of screws are flared excessively, file off flared portion to avoid damage to threads in choke shaft. Be careful not to damage choke shaft or venturi while filing screws.
4. Remove accelerating pump discharge nozzle screw and lift pump discharge nozzle and gaskets out of main body. Invert main body to allow accelerating pump discharge needle to drop out into hand.

THROTTLE BODY DISASSEMBLY

1. Remove accelerating pump operating lever retainer.
2. If necessary, remove throttle stop screw and spring.
3. If necessary to remove throttle plates, lightly scribe throttle plates along throttle shaft and mark each plate and its corresponding bore with a number or letter for proper reinstallation. (Figure 7) Remove throttle plates. Retaining

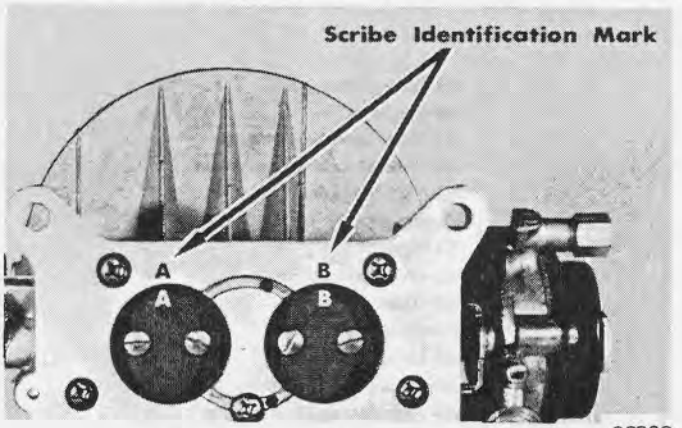


Figure 7. Throttle Plate Removal

screws are staked to throttle shaft. If tips of screws are flared excessively, file off flared portion to avoid thread damage in throttle shaft. Be careful not to damage throttle shaft of venturi while filing screws.

4. Remove fast idle cam lever. Remove throttle shaft return spring from notch on throttle shaft lever. (Figure 2) Slide throttle lever and shaft assembly out of throttle body. Remove accelerating pump cam.

CLEANING and INSPECTION

1. Clean carburetor in a cold immersion-type cleaner, such as Carbon-X (X-55) or its equivalent.

CAUTION: DO NOT immerse any rubber parts, plastic parts, diaphragms and pump plungers in carburetor cleaner. Delrin cam on air throttle lever will withstand normal cleaning in carburetor cleaner.

2. Blow out all passages in castings with compressed air. DO NOT pass drills thru jets or passages.
3. Inspect idle mixture needles for damage.
4. Examine inlet needle and seat for wear. If worn, replace with new inlet needle and seat assembly.
5. Inspect upper and lower surfaces of carburetor castings for damage.
6. Inspect holes in levers for excessive wear or out-of-round condition. If worn, replace levers.
7. Examine fast idle cam for wear or damage.
8. Check all throttle levers and valves for binding or other damage.

REASSEMBLY

NOTE: Make sure that all holes in new gaskets are properly punched and that no foreign material adheres to gaskets. Be certain that accelerating pump diaphragms are not cut or torn.

Carburetor assembly is shown in Figures 2 and 3, preceding.

THROTTLE BODY REASSEMBLY

Refer to Figure 8 for correct location of parts.

1. If throttle plates were removed, place accelerating pump cam on primary throttle shaft. Place end of throttle connecting rod with smallest bend in position in primary throttle lever. Slide throttle shaft into throttle body, guiding throttle connecting rod so that other end fits into secondary throttle lever.

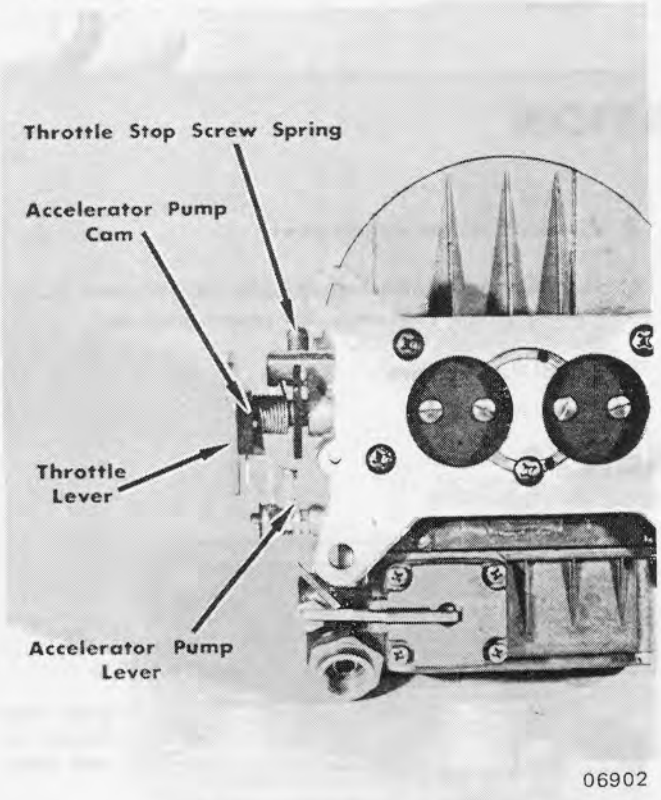


Figure 8. Throttle Lever and Shaft Assembly Installation

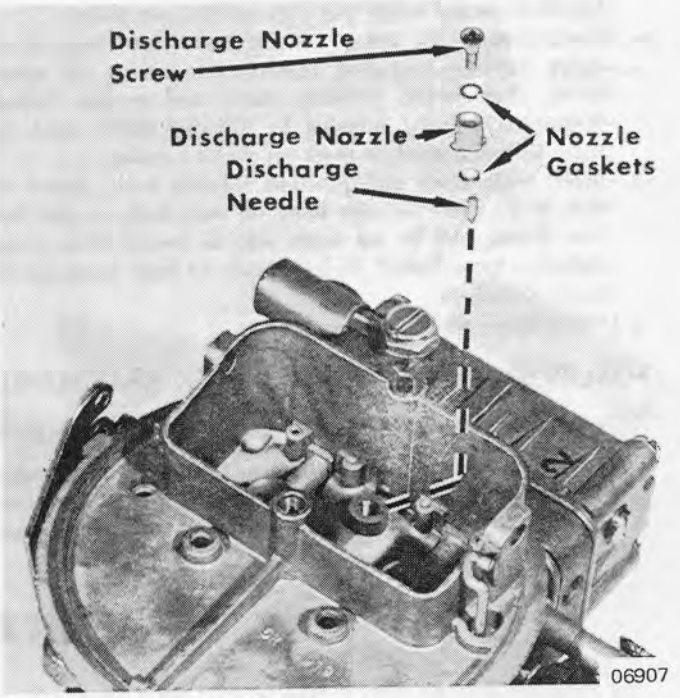


Figure 9. Accelerating Pump Discharge Assembly

2. Position throttle return spring so that small tang fits into slot in throttle lever and long tang rests against throttle body stop. (Figure 8)
3. Secure end of connecting rod with pin retainer.
4. If throttle plates are removed, slide shaft into throttle body. Refer to lines scribed on throttle plates, then install plates in proper location with screws snug but not tight. Close throttle plates and hold throttle body up to the light. Little or no light should be visible between throttle plates and throttle bores. If throttle plates are properly installed and no binding exists when throttle shaft is rotated, tighten throttle plate screws. Stake screws by supporting shaft and plates on block of wood or soft metal bar to prevent shaft from binding.
5. Install fast idle cam lever, lockwasher and screw.
6. Install throttle stop screw and spring.
7. Install accelerating pump operating lever and retainer.

MAIN BODY REASSEMBLY

1. Drop accelerator pump discharge needle into its well. (Figure 9) Lightly seat needle with brass drift and

hammer. Position accelerating pump nozzle and gaskets in main body and install retaining screw.

2. Position choke plate shaft in air horn and install choke plate in shaft. (Figure 2) Install rod seal on choke rod. Slide U-shaped end of choke plate rod thru opening in main body and insert rod end thru inner side of bore in choke lever. Rod end must face outward. Push rod seal into retaining grooves on underside of flame arrestor mounting flange. Position choke thermostat lever link and piston assembly in choke housing. Position fast idle cam assembly on choke housing and install choke housing shaft and lever assembly. (Figure 2) Position lever and piston assembly on choke housing shaft and lever assembly. Install spacer, lockwasher and nut. Place main body assembly on its side and position choke housing gaskets on main body. Insert choke rod in choke housing shaft lever as choke housing is placed into position on main body. Be sure that projection on choke rod is placed under fast idle cam so that cam will be lifted when choke plate is closed. Install choke rod cotter pin with needle-nose pliers.
   Place thermostatic spring housing gasket into position on choke housing (engaging thermostatic spring on spring lever), then install housing clamp and screws. Adjust thermostatic spring housing by aligning index mark on cover with mid-position mark on choke housing.
3. Invert main body and position throttle body gasket on main body. Place throttle body on main body so that fuel inlet fitting will be on same side as accelerating pump operating lever. Install throttle body to main body screws and lockwashers.
4. Install flame arrestor anchor stud.

FUEL BOWL and METERING BLOCK REASSEMBLY

Refer to Figures 2 and 3 for correct location of fuel bowl parts.

1. Place accelerating pump diaphragm spring and diaphragm in accelerating pump chamber. Disphragm must be positioned so that large end of lever disc will be against operating lever. Install cover and tighten retaining screws finger-tight. Make sure that diaphragm is centered, then compress diaphragm with pump operating lever and tighten cover screws. After carburetor is assembled, refer to "Adjustment" for correct adjustment of accelerating pump, following.
2. Install gasket and fuel inlet fitting.
3. Install fuel level sight plug and gasket.
4. Slide baffle plate onto ridges in fuel bowl.
5. Install float spring on float and slide float onto shaft. Be sure that float spring is between ridges on boss on floor of fuel bowl. Install float retainer with needle-nose pliers.
6. Apply petroleum jelly to new "O" ring seal and slide on fuel inlet needle and seat assembly.
7. Position fuel inlet needle and seat assembly in fuel bowl thru top of bowl. Position adjusting nut gasket and nut of fuel inlet needle and seat assembly. Align flat on ID of nut with flat on OD of fuel inlet needle and seat assembly. Install fuel level adjustment lockscrew and gasket.
8. As a preliminary float adjustment, refer to "Adjustments", following, and perform "Float Level Adjustment (Dry)" procedure.
9. Install power valve and gasket in metering block with socket wrench. (Figure 5) Be sure to install correct power valve. Refer to specifications for correct identification number (stamped on flat on base of valve).
10. Install jets in metering block with screwdriver. (Figure 4)
11. Install idle adjusting needles and new gaskets. Turn idle adjusting needles in until they just touch the seat, then back needles off the specified number of turns for a preliminary idle adjustment.
12. Position metering block gasket on dowels (located on back of metering block). Position metering block and gasket on main body, Position baffle plate and gasket on metering block. Place retaining screws and new compression gaskets in fuel bowl. Position bowl on metering block and tighten retaining screws.

INSTALLATION

1. Be sure that all old gasket material is removed from manifold and carburetor mounting flanges. Place new carburetor mounting gasket on manifold.
2. Position carburetor on spacer block. Connect choke heat wires to carburetor. Install carburetor retaining nuts and tighten evenly and alternately to specifications.
3. Connect fuel line to float bowl.
4. Adjust engine idle speed and idle fuel mixture. Refer to "Adjustments", following, for proper procedure.
5. Install flame arrestor.

ADJUSTMENTS

Fuel level float adjustment (dry) is performed only as a bench adjustment. Preliminary idle fuel mixture and idle speed adjustments, automatic choke adjustment and accelerating pump lever and stroke adjustments can be performed with carburetor on bench or installed on engine.

Fuel level adjustment, carburetor linkage adjustment, idle fuel mixture and idle speed adjustments are performed only with carburetor installed on engine.

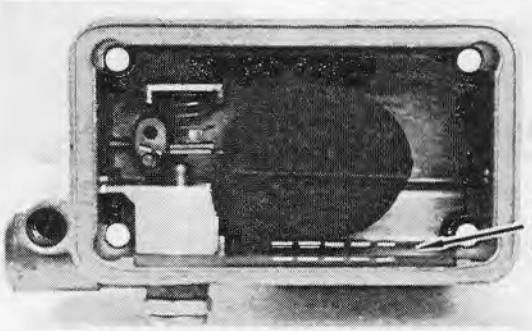


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Figure 10. Dry Float Level Adjustment

FLOAT LEVEL ADJUSTMENT (DRY)

With float bowl upside down, adjust float parallel to bowl floor (Figure 10) by loosening lockscrew and turning adjusting nut.

ACCELERATOR PUMP LEVER CLEARANCE

1. With throttle valves at wide open throttle and pump lever held down, insert a .015" minimum gauge between adjusting nut and operating lever. (Figure 11)
2. Adjust pump over-ride screw until correct clearance is obtained.

NOTE: There must be no free movement of pump lever when throttle is at idle.

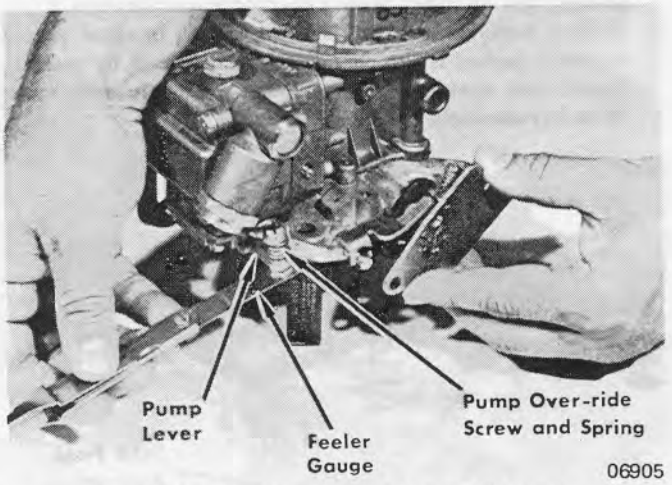


Figure 11. Accelerator Pump Lever Clearance

CHOKE UNLOADER ADJUSTMENT

Choke unloader is a mechanical device to partially open choke at wide open throttle. Adjust as follows:

1. Hold throttle valves in wide open position, insert a 5/32" drill between upper edge of choke valve and inner wall of air horn.
2. Press finger lightly against choke control lever. A slight drag should be felt as drill is pulled out. (Figure 12)
3. To adjust, bend tab on kick-down lever until correct opening has been obtained.

FLOAT LEVEL ADJUSTMENT (WET)

1. With flame arrestor removed and ignition "off", remove sight plug (Figure 13), then remove bowl lower attaching screw furthest from fuel inlet. (Figure 14)
2. Drain off fuel into a shallow pan, using care not to spill fuel and create a fire hazard.
3. Reinstall fuel bowl screw.
4. With engine running, fuel level should be in line with threads at bottom of sight plug port (plus-or-minus 1/32" [.8mm] tolerance).
5. To correct fuel level, loosen lockscrew (Figure 15) and turn adjusting nut clockwise to lower fuel level and counterclockwise to raise fuel level (1/6-turn of adjusting nut equals approximately 1/16" [1.6mm] in fuel level).
6. After adjustment, tighten lockscrew.
7. Operate engine until fuel level is stablized, then recheck level at sight plug.

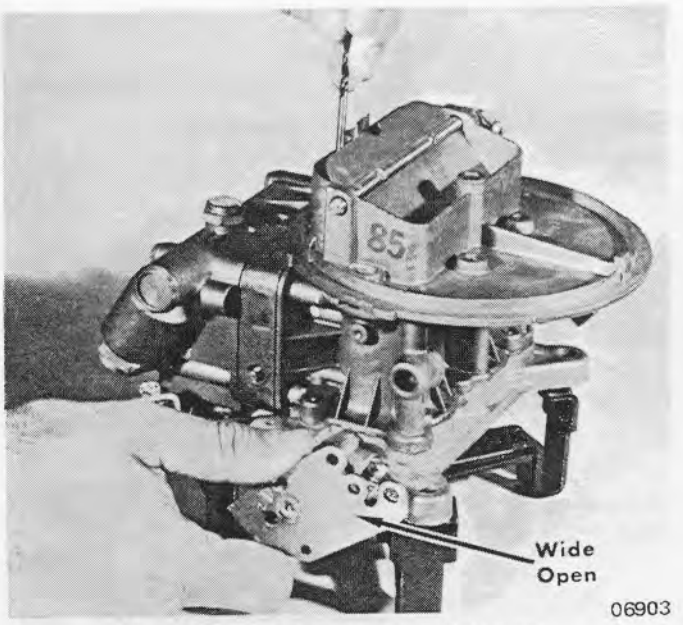


Figure 12. Choke Unloader Adjustment

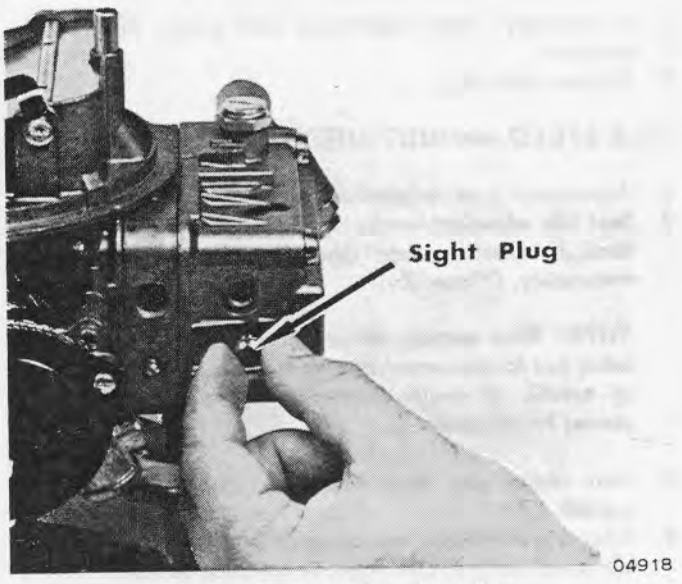


Figure 13. Removing Sight Plug

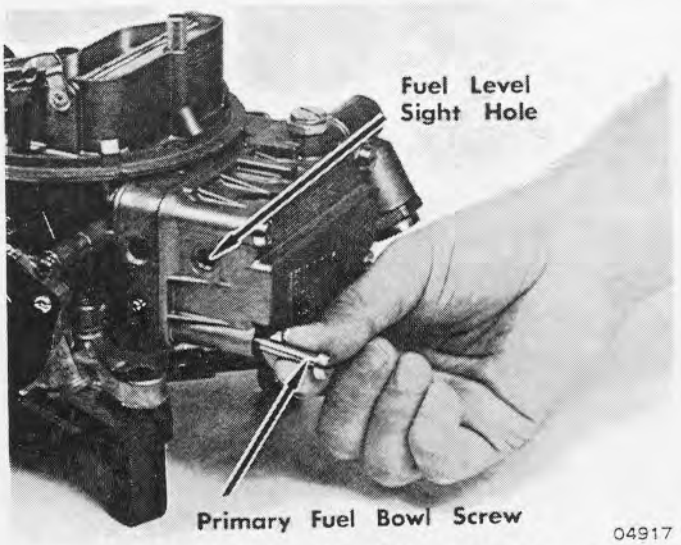


Figure 14. Removing Fuel Bowl Lower Screw

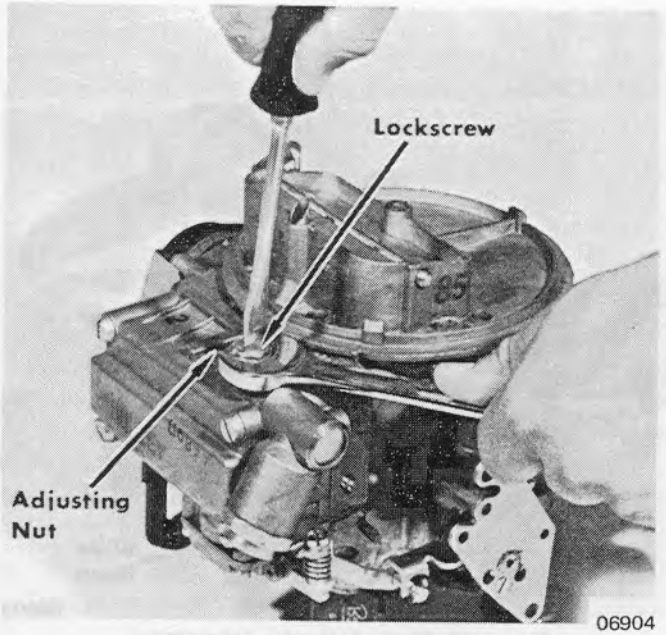


Figure 15. Adjusting Fuel Level

8. If necessary, repeat adjustment until proper fuel level is attained.
9. Replace sight plug.

IDLE SPEED and MIXTURE ADJUSTMENT

1. Adjustment must be made with boat as level as possible.
2. Seat idle adjusting needles lightly and back each off a full turn, if there is doubt that this was not done during reassembly. (Figure 16)

   NOTE: When seating idle adjusting needle, care must be taken not to turn screw tight against seat, thus grooving tip of needle. If needle becomes grooved, a smooth idle cannot be obtained.

3. Start engine and allow operating temperature to reach normal.
4. After engine reaches normal operating temperature, adjust idle speed screw to idle engine at specified RPM.
5. First, set one of the 2 idle adjusting needles for highest steady manifold vacuum reading. If a vacuum gauge is not available, obtain smoothest-running, maximum idle speed by turning idle adjusting needle in until RPM begins to drop off, then backing needle off over "high spot" until RPM again drops off. Set idle adjusting needle halfway between 2 points for satisfactory idle mixture setting. Repeat procedure with other needle. Should these adjustments show an increase in idle RPM, reset idle speed screw to obtain specified idle RPM and again adjust idle adjusting needles.

AUTOMATIC CHOKE ADJUSTMENT

1. Automatic choke is set accurately at factory to give best possible all-weather operation. To return choke to original setting, line up index mark with proper specification.
2. If, for some reason, a richer or leaner mixture during warmup period is desired, it can be obtained by rotating thermostat cover. Never set index mark on cover more than 2 graduations off specified settings.

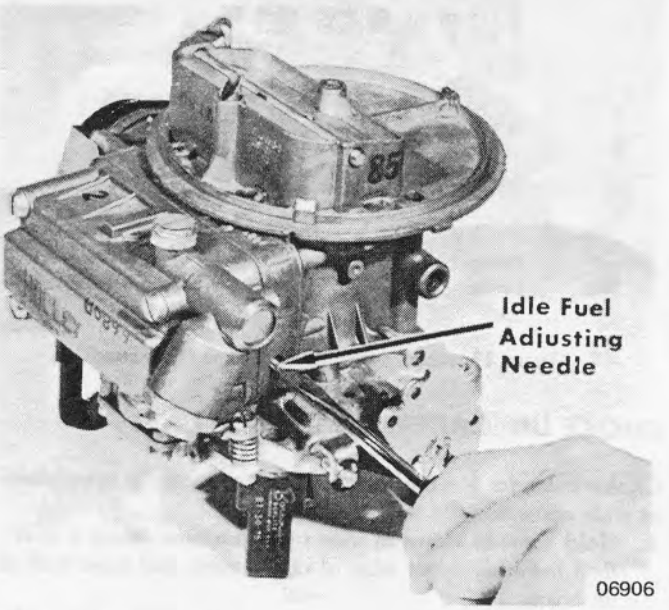
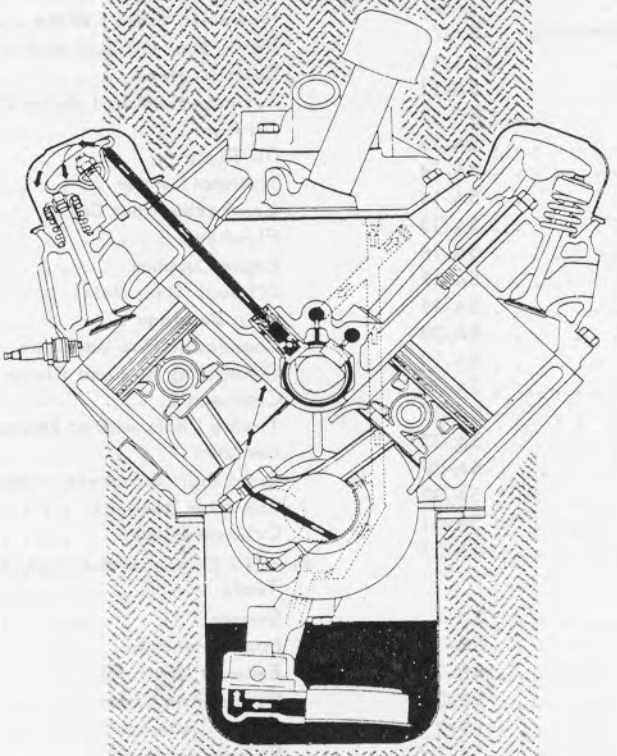


Figure 16. Adjusting Idle Fuel Mixture

MERCRUISER
SECTION 5



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SECTION 5 - ENGINE

MERCRUISER

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MERCURY MARINE

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ENGINE MECHANICAL - 4 and 6-CYLINDER MODELS

GENERAL

In-line engines with 153, 181, 194, 230, 250 and 292 cu. in. displacements are covered in this section.
Full pressure lubrication thru a full flow oil filter is furnished by a gear-type oil pump. Distributor, driven by a helical gear on camshaft, drives oil pump. Main oil gallery feeds oil thru drilled passages to camshaft and crankshaft to lubricate bearings. Main oil gallery also feeds valve lifters which, thru push rods, feed individually-mounted rocker arms.

Cubic inch displacement of each MerCruiser model is listed below.

Some Repairs, Listed in This Section, Must Be Completed with Engine Removed from Boat. Engine Removal Depends Upon Type of Repair and Boat Design. Place Engine on Engine Stand for Major Repairs.

MODEL	NO. OF CYLINDERS	DISPLACEMENT
MerCruiser 110	4	153 Cu. In.
MerCruiser 120	4	153 Cu. In.
MerCruiser 140	4	181 Cu. In.
MerCruiser 140	6	194 Cu. In.
MerCruiser 150	6	230 Cu. In.
MerCruiser 160	6	250 Cu. In.
MerCruiser 165	6	250 Cu. In.
MerCruiser 200	6	292 Cu. In.

INTAKE and EXHAUST MANIFOLD

REMOVAL

1. Disconnect exhaust hose.
2. Disconnect lines at carburetor.
3. Disconnect crankcase ventilation hose at rocker arm cover.
4. Remove manifold fasteners; remove manifold assembly and discard gaskets.
5. Check for cracks in manifold castings.

CLEANING and INSPECTION

1. Clean gasket material from all surfaces and wash parts in solvent.
2. Inspect all parts carefully. Machined surfaces must be clean and free of all marks of deep scratches, or water leaks may result.
3. Check water passages for sand, silt or foreign material. Passages must be clean for efficient cooling.
4. If more thorough inspection is desired, pipe plugs may be removed from exhaust manifold elbow and exhaust pipe elbow.

INSTALLATION

1. Clean gasket surfaces on cylinder head and manifold.
2. Position new gasket on head and carefully install manifold in position, making sure gasket is in place.
3. Install fasteners and washers while holding manifold in place.
4. Tighten evenly and securely, starting in center and working out toward ends.

NOTE: Vibration will occur if fasteners, which secure manifold to cylinder head, loosen from compression of manifold to head gasket.

5. Connect crankcase ventilation hose at rocker arm cover.
6. Connect lines and choke tube.
7. Replace exhaust hose.
8. Start engine, check for leaks and adjust carburetor idle speed and mixture.

EXHAUST WATER SHUTTER

If engine is equipped with exhaust shutter in exhaust tube, it may make a rattling noise at idle speed. This noise is caused by a loose fit between shutter shaft and support brackets and can be corrected as follows:

1. Loosen hose clamps which fasten exhaust bellows to exhaust tube.
2. Remove screws, which fasten exhaust elbow to manifold, and remove elbow and bellows. Scrape gasket material from manifold and elbow.
3. Thoroughly clean area between shutter support brackets and exhaust tube with cleaning solvent and a small brush or pipe cleaner.
4. Fill entire area between support brackets and tube with Sealant (C-92-52238-1). Allow sealant to cure for 24 hours.
5. Reinstall elbow, using new gasket, and connect bellows. Tighten hose clamps securely.

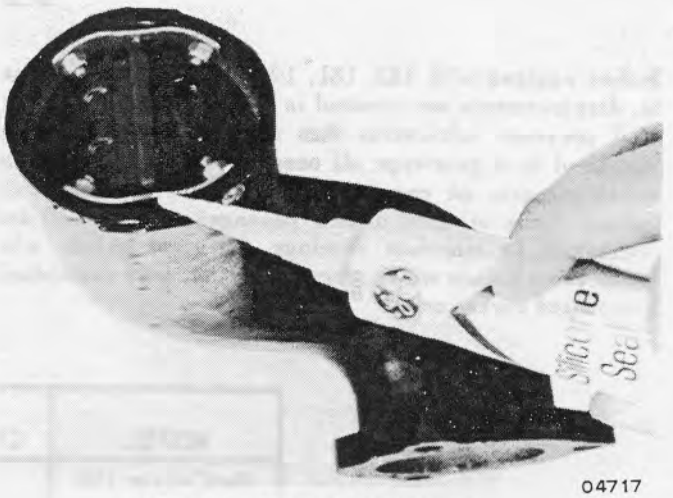

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Figure 1. Sealant Application

ROCKER ARM COVER

REMOVAL

1. Disconnect crankcase ventilation hose at rocker arm cover.
2. Remove temperature wire from rocker arm cover clips.
3. Remove attaching bolts.
4. Remove rocker arm cover.

INSTALLATION

1. Clean gasket surfaces on cylinder head and rocker arm cover with degreaser, then, using a new gasket, install rocker arm cover and torque to specifications.

NOTE: A crankcase vent baffle kit (B-45369A1) is available for installation in valve cover of 153 cu. in. engines, Serial No. 2220847 and below. Installation of this kit will eliminate possibility that crankcase oil will be carried over to carburetor via crankcase breather hose which extends from valve cover to carburetor.

2. Connect temperature wire at rocker arm cover clips.
3. Connect crankcase ventilation hoses.

VALVE MECHANISM

REMOVAL

1. Remove rocker arm cover as outlined.
2. Remove rocker arm nuts, rocker arm balls, rocker arms and push rods.

NOTE: Place rocker arms, rocker arm balls and push rods in a rack so that they may be reinstalled in same location.

INSTALLATION

NOTE: Whenever new rocker arms and/or rocker arm balls are being installed, coat bearing surfaces of rocker arms and rocker arm balls with Molykote or equivalent.

1. Install push rods. Be sure that push rods seat in lifter socket.
2. Install rocker arms, rocker arm balls and rocker arm nuts. Tighten rocker arm nuts until all lash is eliminated.
3. Install rocker arm cover as outlined.
4. Adjust carburetor idle speed and mixture.

VALVE ADJUSTMENT

ENGINE STOPPED

1. Remove valve cover.
2. Adjust valves when lifter is on base circle of camshaft lobe as follows:
   a. Mark distributor housing with chalk at No. 1 and No. 6 cylinder positions (plug wire), then disconnect plug wires at spark plugs and coil and remove distributor cap and plug wire assembly (if not previously done).
   b. Crank engine until distributor rotor points to No. 1 cylinder position and breaker points are open. Following valves can be adjusted with engine in No. 1 firing position.

      No. 1 Cylinder--Exhaust and Intake
      No. 2 Cylinder--Intake
      No. 3 Cylinder--Exhaust
      No. 4 Cylinder--Intake
      No. 5 Cylinder--Exhaust

c. Back out adjusting nut until lash is felt at push rod, then turn in adjusting nut until all lash is removed. This can be determined by checking push rod side play while turning adjusting nut. (Figure 1) When play is removed, turn adjusting nut in ¾ additional turn (to center lifter plunger).
d. Crank engine until distributor rotor points to No. 6 position and breaker points are open. Following valves can be adjusted with engine in No. 6 firing position:

No. 2 Cylinder--Exhaust
No. 3 Cylinder--Intake
No. 4 Cylinder--Exhaust
No. 5 Cylinder--Intake
No. 6 Cylinder--Intake and Exhaust

3. Install distributor cap and spark plug wire assembly.
4. Install rocker arm cover and adjust carburetor.

ENGINE RUNNING

Following procedure, performed with engine running, should be completed only if readjustment is required.
1. After warming-up engine, remove valve cover and install new valve cover gasket on cylinder head to prevent oil from running out.
2. With engine running at idle, back off valve rocker arm nut until valve rocker arm starts to clatter. (Figure 1)
3. Turn rocker arm nut down slowly until clatter just stops. This is zero lash position.
4. Turn nut down ¼ additional turn and pause 10 seconds until engine runs smoothly. Repeat additional ¼ turns, pausing 10 seconds each time, until nut has been turned down ¾ turn from zero lash position.

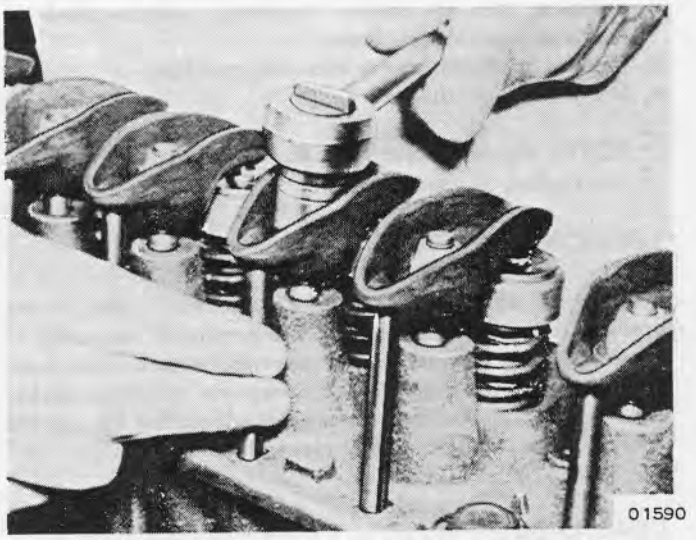


Figure 1. Valve Adjustment

NOTE: This ¾ turn pre-load adjustment must be done slowly to allow lifter to adjust itself, thus preventing possibility of interference between inlet valve head and top of piston which might result in internal damage and/or bend push rods. Replace lifters.

5. Repeat Steps 2-3-4 to adjust other valves.
6. Install valve cover, using new gasket.

VALVE LIFTERS

Hydraulic valve lifters seldom require attention. Lifters are simple in design, readjustments are not necessary and lifter servicing requires only that care and cleanliness be exercised in handling of parts.

LOCATING NOISY LIFTERS

Use a piece of garden hose approximately 4 ft. (1.22m) in length to locate a noisy valve lifter. Place one end of hose near end of each intake and exhaust valve with other end of hose to the ear. Sound, thus, is localized, making it easy to determine which lifter is at fault. Another method is to place a finger on face of valve spring retainer. If lifter is not functioning properly, a distinct shock will be felt when valve returns to its seat. General types of valve lifter noise are:

1. Hard Rapping Noise - Usually caused by plunger becoming tight in bore of lifter body to such an extent that return spring can no longer push plunger back up to working position. Probable causes are -
   a. Excessive varnish or carbon deposit which causes abnormal stickiness.
   b. Galling or "pickup" between plunger and bore of lifter body, usually caused by an abrasive piece of dirt or metal wedging between plunger and lifter body.
2. Moderate Rapping Noise - Probable causes are -
   a. Excessively high leakdown rate.
   b. Leaky check valve seat.
   c. Improper adjustment.
3. General Noise Throughout Valve Train - This, in most cases, will be a definite indication of insufficient oil supply or improper adjustment.
4. Intermittent Clicking - Probable causes are -
   a. A microscopic piece of dirt momentarily caught between ball seat and check valve ball.
   b. In rare cases, ball itself may be out-of-round or have a flat spot.
   c. Improper adjustment.

In most cases, where noise exists in one or more lifters, all lifter units should be removed, disassembled, cleaned in a solvent, reassembled and reinstalled in engine. If dirt, varnish, carbon, etc, is shown to exist in one unit, it likely exists in all units. Thus, it would be only a matter of time before all lifters cause trouble.

REMOVAL

1. Remove valve mechanism as outlined.
2. Mark distributor housing with chalk at each cylinder position (plug wire), then disconnect plug wires at spark plugs and coil and remove distributor cap and plug wire assembly.

3. Crank engine until distributor rotor points to No. 1 position, then disconnect distributor primary lead at coil and remove distributor.
4. Remove push rod covers (discard gaskets).
5. Remove valve lifters.

NOTE: Place valve lifters in a rack so they may be reinstalled in same location.

SERVICING

Two types of hydraulic lifters are used. Both types operate on same principle and are serviced basically in same manner. Complete lifter assemblies are interchangeable, but parts from one lifter are not interchangeable with another. Both lifters are easily identified by outside configuration of lifter body. Identify them as lifter "A" and lifter "B". (Figure 2)

DISASSEMBLY

1. Hold plunger down with push rod and remove push rod seat retainer with blade of small screwdriver.
2. Remove push rod seat and metering valve (lifter "A") or push rod seat and inertia valve assembly (lifter "B"). (Figure 2)
3. Remove plunger, ball check valve assembly and plunger spring.
4. Remove ball check valve and spring by prying ball retainer loose from plunger with blade of small screwdriver. (Figure 3)

CLEANING and INSPECTION

Thoroughly clean all parts in cleaning solvent and inspect parts carefully. If any parts are damaged or worn, entire lifter assembly should be replaced. If lifter body wall is scuffed or worn, inspect cylinder block lifter bore. If bottom of lifter is scuffed or worn, inspect camshaft lobe. If push rod seat is scuffed or worn, inspect push rod.

NOTE: Do not remove inertia valve and retainer (lifter "B") (Figure 2) from push rod seat. To check valve, shake push rod seat and inertia valve assembly, and valve should move.

REASSEMBLY

1. Place check ball on small hole in bottom of plunger.
2. Insert check ball spring on seat in ball retainer and place retainer over ball so that spring rests on ball. Carefully press retainer into position in plunger with blade of a small screwdriver. (Figure 4)
3. Place plunger spring over ball retainer and slide lifter body over spring and plunger, being careful that oil feed holes in lifter body and plunger line up.
4. Fill assembly with oil, then insert end of a 1/8" drift pin into plunger and press down strongly. At this point, oil holes in lifter body and plunger assembly will be aligned. (Figure 5)

CAUTION: Do not attempt to force or pump the plunger.

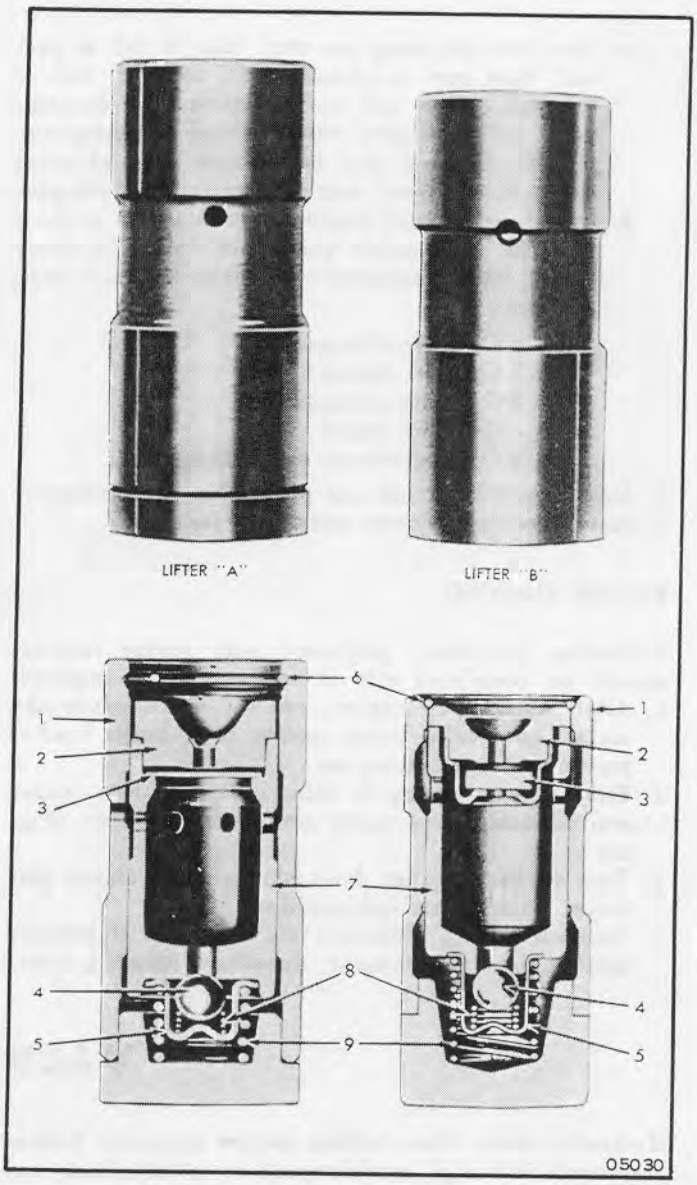


Figure 2. Hydraulic Valve Lifters

1 Lifter Body
2 Push Rod Seat
3 Metering Valve (Lifter "A")
Inertia Valve (Lifter "B")
4 Check Ball
5 Check Ball Retainer
6 Push Rod Seat Retainer
7 Plunger
8 Check Ball Spring
9 Plunger Spring

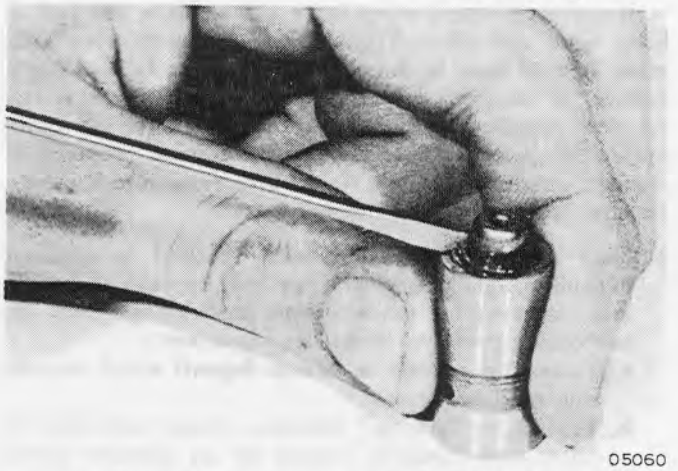


Figure 3. Removing Ball Check Valve

5. Insert a 1/16" drift pin thru both oil holes to hold plunger down against lifter spring tension. (Figure 5)

   NOTE: On lifter "B" (Figure 2), drift pin must not extend inside plunger.

6. Remove 1/8" drift pin and refill assembly with oil.
7. Install metering valve and push rod seat (lifter "A") or push rod seat and inertia valve assembly (lifter "B"). (Figure 2)
8. Install push rod seat retainer, press down on push rod seat and remove 1/16" drift pin from oil holes. Lifter now is completely assembled, filled with oil and ready for installation.

   NOTE: Before installing a new lifter, coat bottom of lifter with Molykote or equivalent.

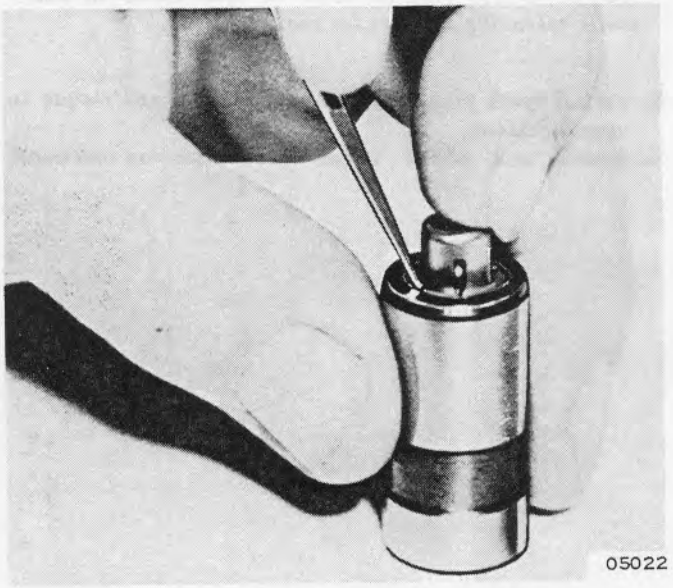


Figure 4. Installing Ball Check Valve

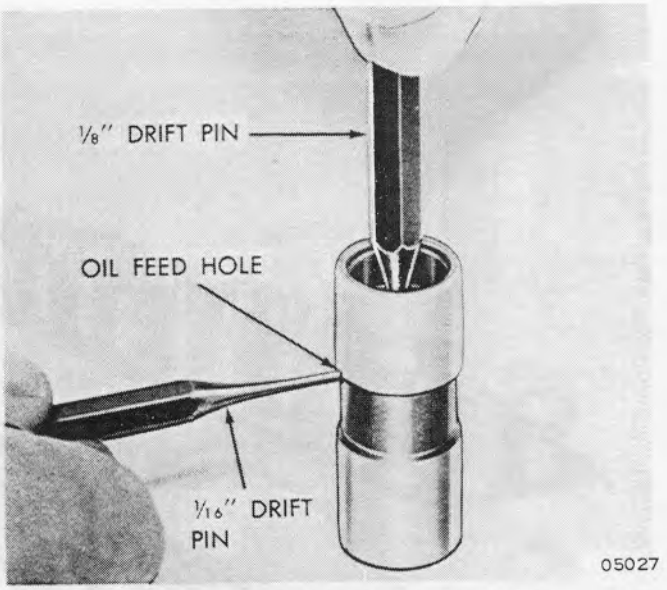


Figure 5. Assembling Hydraulic Lifters

INSTALLATION

1. Install valve lifters.

   NOTE: Whenever new valve lifters are being installed, coat foot of valve lifters with Molykote or equivalent.

2. Install push rod covers, using new gaskets, and torque to specifications.
3. Install distributor, positioning rotor to No. 1 cylinder position, then connect primary lead at coil.
4. Install and adjust valve mechanism as outlined.
5. Adjust ignition timing and carburetor idle speed and mixture.

VALVE STEM and/or VALVE SPRING

REPLACEMENT

1. Remove rocker arm cover as outlined.
2. Remove spark plug, rocker arm and push rod on cylinder(s) to be serviced.
3. Apply compressed air to spark plug hole to hold valves in place.

   NOTE: A tool to apply air to cylinder is available thru local jobbers or may be hand-made. To make this tool, chisel spark plug as shown in Figure 6, then drive porcelain out of plug by tapping center electrode against a hard block. Using a 3/8" pipe tap, cut threads in remaining portion of spark plug and assemble as shown in Figure 6.

4. Compress valve spring with Tool J-5892 and remove valve locks, valve cap, valve shield and valve spring. (Figure 7)

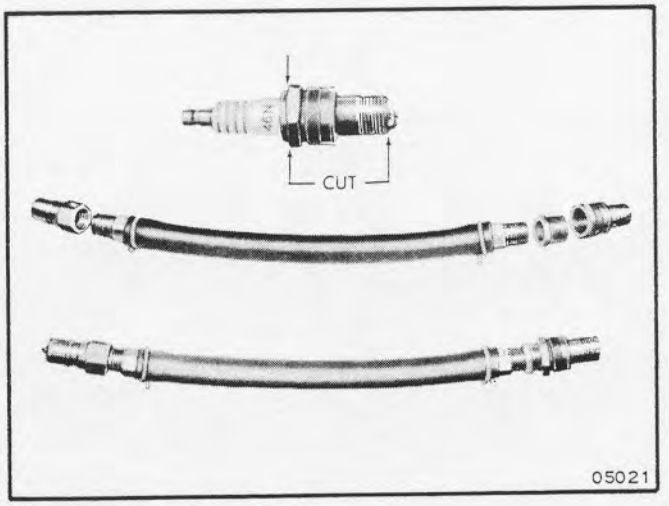


Figure 6. Air Adaptor Tool

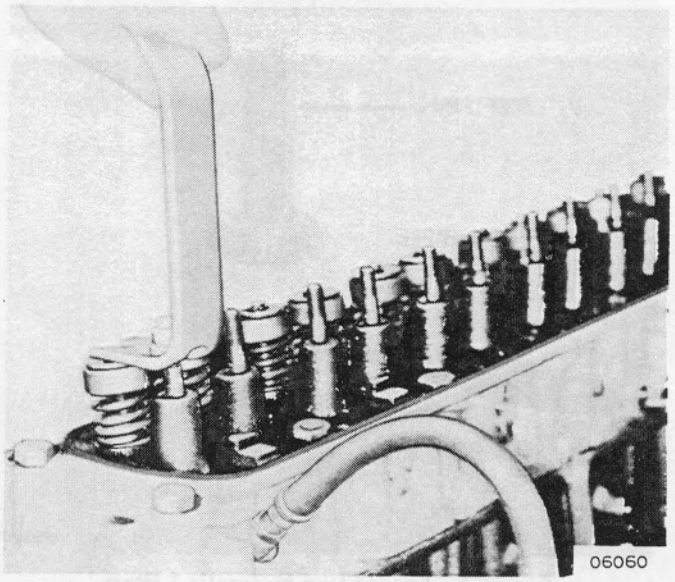


Figure 7. Compressing Valve Spring

5. Remove valve stem oil seal.
6. To replace, set valve spring, valve shield and valve cap in place. Close, coiled end of spring is installed against cylinder head. Compress spring with Tool J-5892 and install oil seal in lower groove of stem, making sure that seal is flat and not twisted.

   NOTE: A light coat of oil on seal will help prevent twisting.

7. Install valve locks and release compressor tool. Be sure that locks seat properly in upper groove of the stem.

   NOTE: Grease may be used to hold locks in place while releasing compressor tool.

8. Install spark plug, using a new gasket, and torque to specifications.
9. Install and adjust valve mechanism as outlined.

CYLINDER HEAD ASSEMBLIES

REMOVAL

1. Remove manifold assembly as outlined.
2. Remove valve mechanism as outlined.
3. Drain water from cylinder block and disconnect wires from temperature sending units.
4. Disconnect upper cooling hose at water outlet housing.
5. Remove coil.
6. Remove cylinder head bolts, cylinder head and gasket. Place cylinder head on 2 blocks of wood to prevent damage.

INSTALLATION

CAUTION: Gasket surfaces on both head and block must be clean of any foreign matter and free of nicks or deep scratches. Cylinder bolt threads in block and threads on cylinder head bolt must be cleaned. Dirt will affect bolt torque. Do Not use gasket sealer on composition steel asbestos gaskets.

1. Place gasket in position over dowel pins with bead up.
2. Carefully guide cylinder head into place over dowel pins and gasket.
3. Coat threads of cylinder head bolts with sealing compound and install finger-tight.
4. Tighten cylinder head bolts a little at a time in sequence shown on torque sequence chart (Figure 1) until specified torque is reached.

NOTE: Be sure to torque cylinder head on all 6-cylinder engines while performing 20-hour checkup. Failure to retorque could result in poor engine performance, blown cylinder head gaskets, burned valves, warped cylinder head or all four.

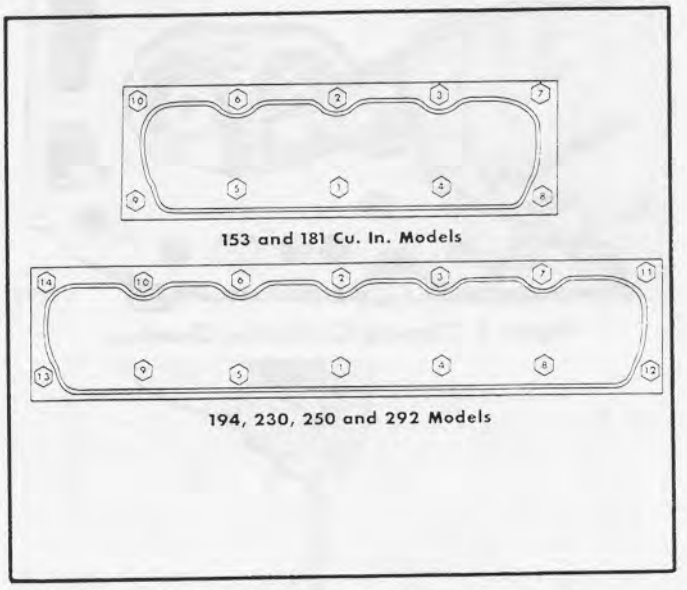


Figure 1. Cylinder Head Torque Sequence

5. Install coil (if removed).
6. Connect cooling hoses.
7. Connect temperature sending unit wires.
8. Install manifold assembly as outlined.
9. Install and adjust valve mechansim as outlined.

NOTE: DO NOT install rocker arm cover.

10. Start engine and allow to warm up, retorque cylinder head and readjust valves.

CYLINDER HEAD ASSEMBLIES and VALVE CONDITIONING

DISASSEMBLY

1. With cylinder head removed, remove valve rocker arm nuts, balls and rocker arms.
2. Compress the valve springs with Tool J-8062 (Figure 2) and remove valve keys. Release compressor tool and remove spring caps, spring shields (if so equipped), springs and spring damper, then remove oil seals and valve spring shims.
3. Remove valves from cylinder head and place them in a rack in their proper sequence for later assembly in their original positions.

CLEANING

1. Clean all carbon from combustion chambers and valve ports with Tool J-8089. (Figure 3)
2. Thoroughly clean valve guides with Tool J-8101. (Figure 4)
3. Clean all carbon and sludge from push rods, rocker arms and push rod guides.
4. Clean valve stems and heads on a buffing wheel.
5. Clean carbon deposits from head gasket mating surface.

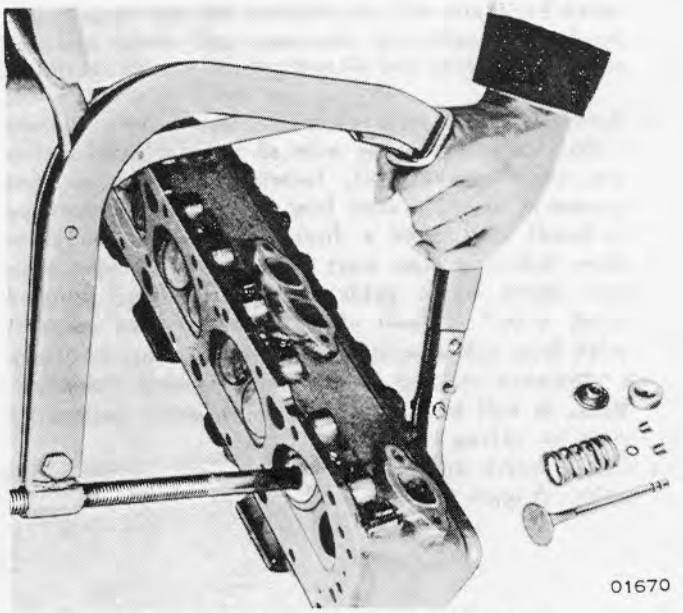


Figure 2. Compressing Valve Spring

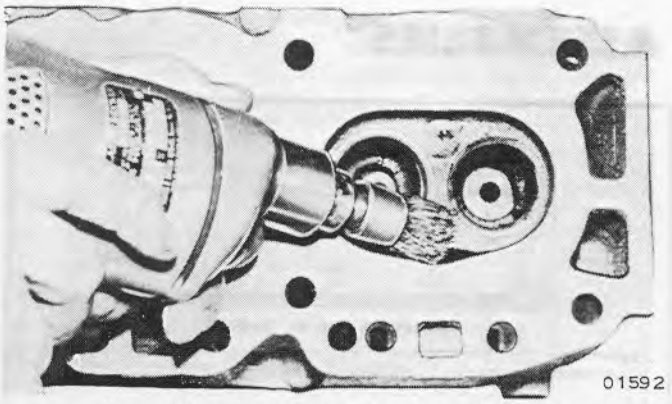


Figure 3. Cleaning Combustion Chambers

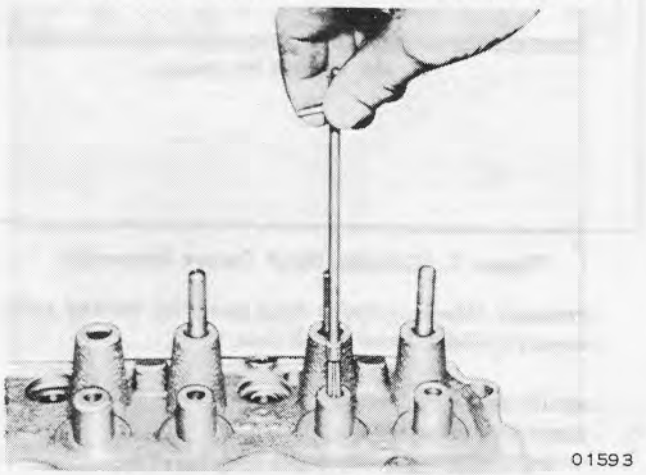


Figure 4. Cleaning Valve Guides

INSPECTION

1. Inspect cylinder head for cracks in exhaust ports, combustion chambers or external cracks to water chamber.
2. Inspect valves for burned heads, cracked faces or damaged stems.

NOTE: Excessive valve stem to bore clearance will cause excessive oil consumption and may cause valve breakage. Insufficient clearance will result in noisy and sticky valves and disturb smooth engine operation.

3. Measure valve stem clearance as follows: Clamp a dial indicator on one side of cylinder head rocker arm cover gasket rail, locating indicator so that movement of valve stem from side-to-side (crosswise to head) will cause a direct movement of indicator stem. Indicator stem must contact side of valve stem just above valve guide. With valve head dropped about 1/16" (1.6mm) off valve seat, move stem of valve from side-to-side. using light pressure to obtain a clearance reading. If clearance exceeds specifications, it will be necessary to ream valve guides for oversize valves as outlined.
4. Check valve spring tension with Tool J-8056 spring tester. (Figure 5)

NOTE: Compress springs to specified height and check against specification chart. Replace if not within 10 lbs. of specified load (without dampers).

5. Inspect rocker arm studs for wear or damage.

NOTE: Coat threads on cylinder head end of rocker arm studs with sealer before assembling to cylinder head.

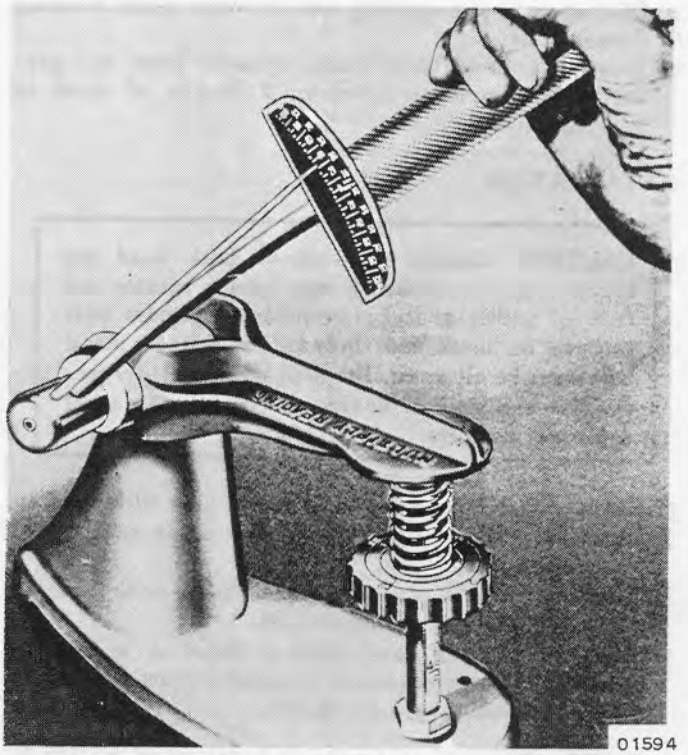


Figure 5. Checking Valve Spring Tension

ROCKER ARM STUDS

Rocker arm studs with damaged threads or with loose fit in cylinder heads should be replaced with new studs available in .003" and .013" (.076mm and .330mm) oversize. Studs may be installed after reaming holes as follows:

1. Remove old stud by placing Tool J-5802-1 over stud, installing nut and flat washer and removing stud by turning nut. (Figure 6)
2. Ream hole for oversize stud with Tool J-5715 for .003" oversize or Tool J-6036 for .013" oversize. (Figure 7)

CAUTION: Do not attempt to install an oversize stud without reaming stud hole.

3. Coat press-fit area of stud with lubricant. Install new stud, using Tool J-6880 as a guide. Gauge should bottom on head. (Figure 8)

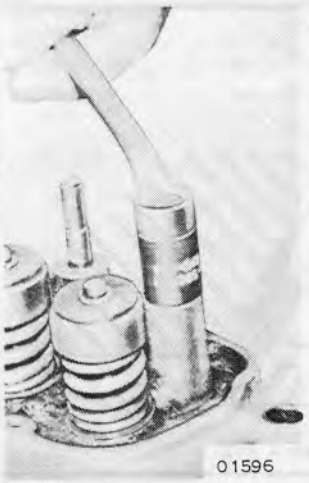


Figure 6. Removing Rocker Arm Stud

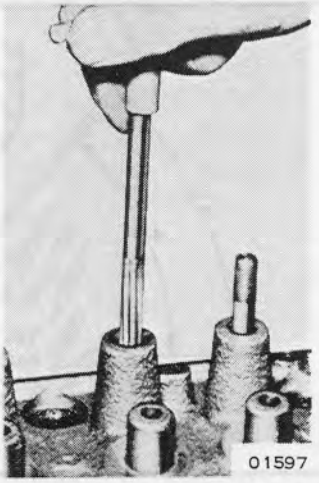


Figure 7. Reaming Rocker Arm Stud Bore

VALVE GUIDE BORES

Valves with oversize stems are available (see specifications). To ream valve guide bores for .015" (.381mm) oversize valves, use Tool J-5830-2 and for standard, use Tool J-4822. (Figure 9)

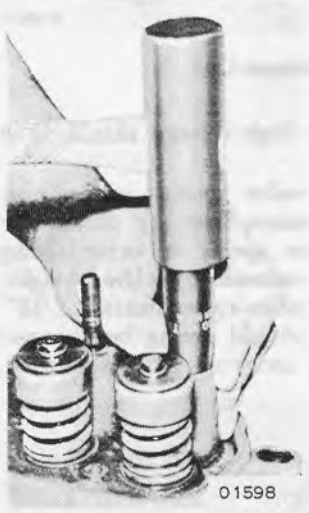


Figure 8. Installing Rocker Arm Stud

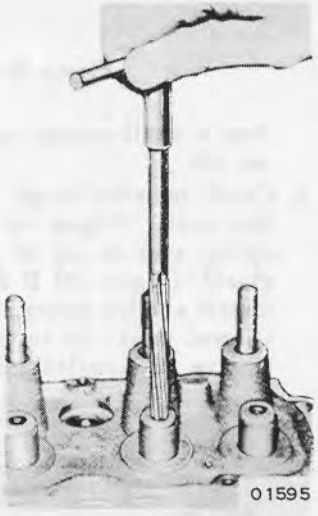


Figure 9. Reaming Valve Guide

VALVE SEATS

1. Valves must seat perfect for the engine to deliver the power and performance built into it.
2. Good contact between each valve and its seat in head is imperative to insure that heat in valve head will be properly carried away (cooled).
3. Recommendations of equipment manufacturer for reseating valve seats should be carefully followed to attain proper results. Regardless of what type of equipment is used, however, it is essential that valve guide bores be free from carbon or dirt.
4. After grinding valve seat, measure concentricity. (Figure 10)

NOTE: Valve seats should be concentric to within .002" (.051mm) total indicator reading.

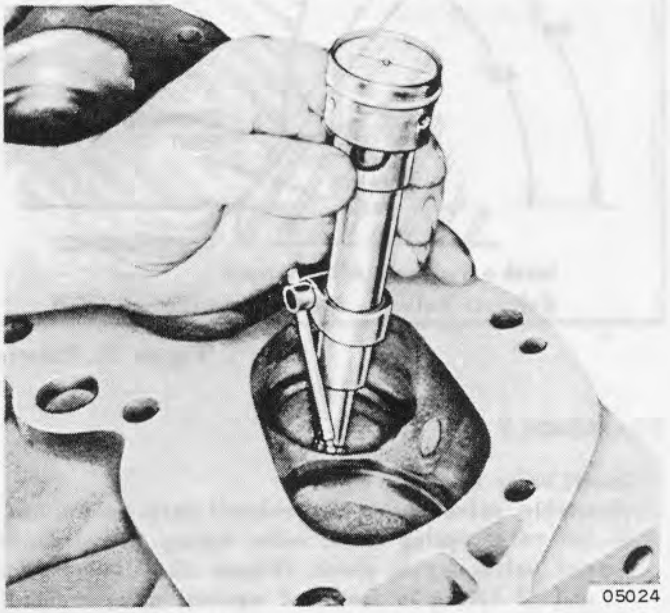


Figure 10. Measuring Valve Seat Concentricity

VALVES

Pitted valves can be refaced to proper angle (Figure 11) thus insuring correct relation between head and stem on valve refacing mechanism. Valve stems, which show excessive wear or valves that are warped excessively, should be replaced. When a valve head (warped excessively) is refaced, a knife edge will be ground on part or all of valve head due to amount of metal that must be removed to completely reface. Knife edges lead to breakage, burning or pre-ignition from heat localizing on this knife edge. If edge of valve head is less than 1/32" (.8mm) thickness after grinding, replace valve.
Recommendations of equipment manufacturer for refacing valves should be carefully followed to obtain best results.

NOTE: Only extreme end of valve stem is hardened to resist wear. Do not grind end of stem excessively.

1. After cleaning valve face and cylinder head valve seat of grinding particles, make pencil marks about 1/4" (6.4mm) apart across valve face, place valve in cylinder head and give valve 1/2-turn in each direction while exerting firm pressure on head of valve.
2. Remove valve and check face carefully. If all pencil marks have not been removed at point of contact with valve seat, it will be necessary to repeat refacing operation and again recheck for proper seating.
3. Grind and check remaining valves in same manner.

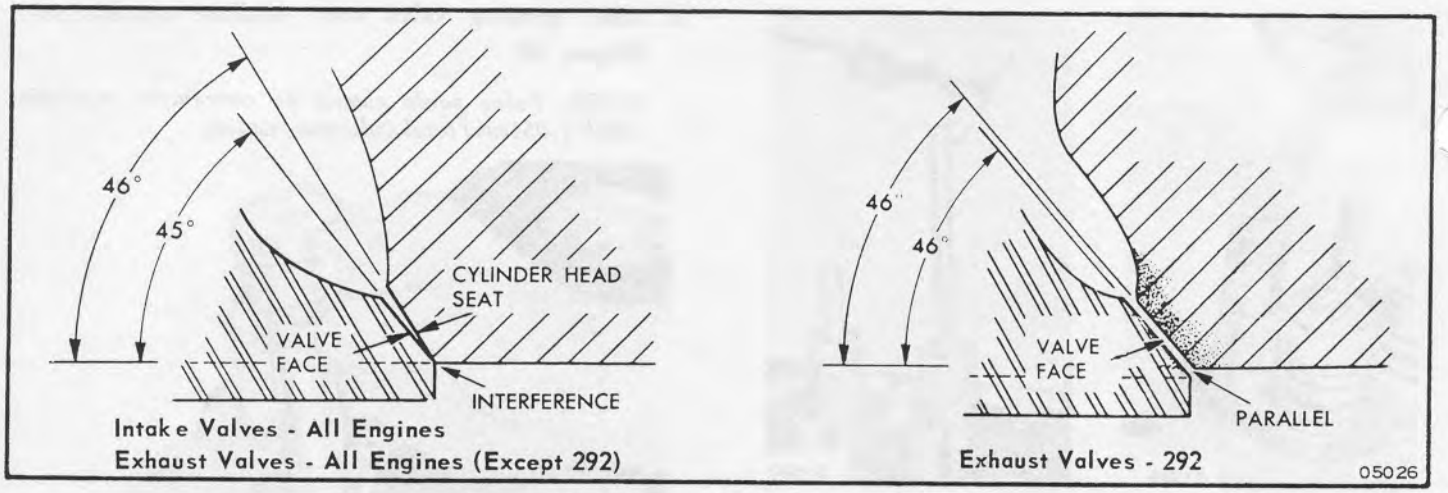


Figure 11. Relation of Valve and Seat Angles

REASSEMBLY

1. Insert valve in proper port.
2. Assemble valve spring and related parts as follows:
   a. Set valve spring shim, valve spring, valve shield and valve cap in place. (Figure 12) Close, coiled end of spring is installed against cylinder head.
   b. Compress spring with Tool J-8062.
   c. Install oil seal in lower groove of stem, making sure that seal is flat and not twisted.

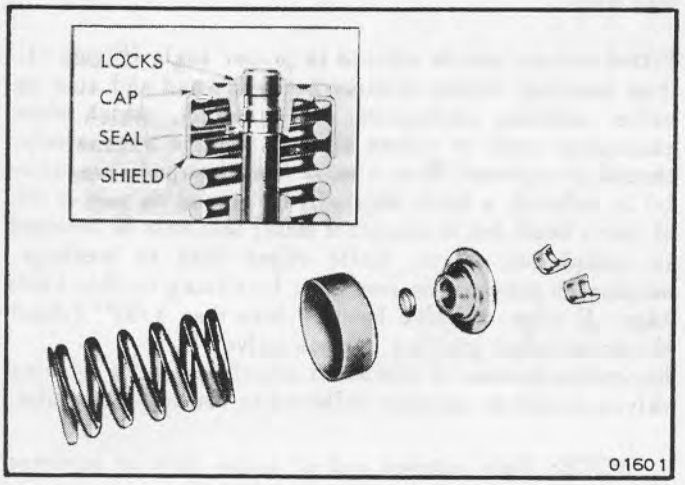


Figure 12. Valve Spring Installation

   d. Install valve locks and release compressor tool, making sure that locks seat properly in upper groove of valve stem.
3. Install remaining valves.
4. Check each valve stem oil seal by placing a vacuum cup or similar device over end of valve stem and against cap. Operate vacuum cup and make sure that no air leaks past seal. A vacuum cup can be made from a small syringe and a high voltage shield. (Figure 13)

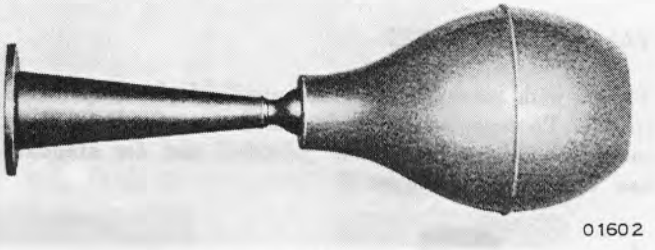


Figure 13. Vacuum Cup

5. Check installed height of valve springs with narrow thin scale. (Figure 14) Measure from top of shim or spring seat to top of valve spring or valve spring shield. (Figure 14) If this exceeds specified height, install a valve spring seat shim approximately 1/16" (1.6mm) thick. At no time should spring be shimmed to give an installed height under minimum specified.

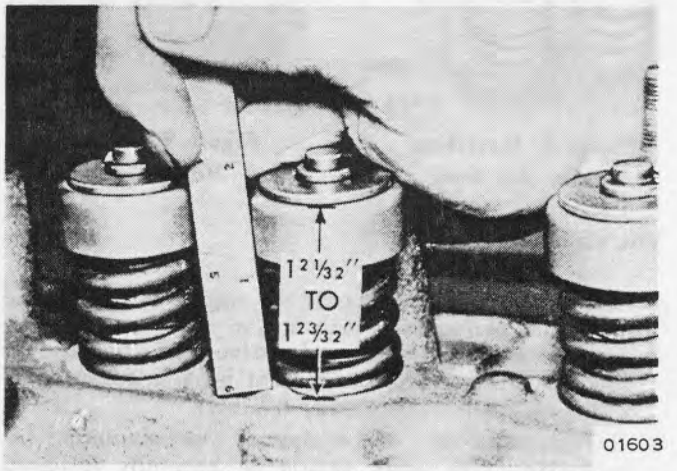


Figure 14. Checking Valve Spring Installed Height

OIL PAN

REMOVAL

1. Disconnect battery.
2. Drain engine oil.
3. Remove starter motor.
4. Remove oil pan screws, oil pan, gaskets and end seals.

INSTALLATION

1. Thoroughly clean all gasket sealing surfaces.
2. Install rear seal in rear main bearing cap.
3. Install front seal on timing gear cover.
4. Install side gaskets on cylinder block, using grease as a retainer. Side gasket tabs index into notches of front seal.
5. Install oil pan.
6. Install starter motor.
7. Fill crankcase with oil.
8. Connect battery.

OIL PUMP

Oil pump consists of 2 gears and a pressure regulator valve enclosed in a 2-piece housing. Oil pump is driven by distributor shaft which is driven by a helical gear on camshaft. A baffle is incorporated on pickup screen to eliminate pressure loss.

REMOVAL

1. Remove oil pan as outlined.
2. Remove flange mounting bolts and pickup pipe bolt, then remove pump and screen as an assembly.

INSTALLATION

1. Align oil pump drive shafts to match with distributor tang, then install oil pump to block, positioning flange over distributor lower bushing. Use no gasket.

   NOTE: Oil pump should slide easily into place. If not, remove and reposition slot to align with distributor tang.

2. Install oil pan as outlined.

DISASSEMBLY

1. Remove pump cover attaching screws, pump cover and pump cover gasket.

   NOTE: Mark gear teeth so they may be reassembled with same teeth indexing.

2. Remove idler gear and drive gear and shaft from pump body.
3. Remove pressure regulator valve retaining pin, pressure regulator valve and related parts.
4. If pickup screen and pipe assembly need replacing, mount pump in a soft-jawed vise and extract pipe from pump.

CAUTION: Do not disturb pickup screen on pipe which is serviced as an assembly.

REASSEMBLY

1. If pickup screen and pipe assembly was removed, replace with a new part. Loss of press fit condition could result in air leak and loss of oil pressure. Mount pump in soft-jawed vise and apply sealer to end of pipe with Tool J-8369. Tap pipe in place with plastic hammer.

CAUTION: Be careful of twisting, shearing or collapsing pipe while installing in pump. Pickup screen must be parallel to bottom of oil pan when oil pump is installed.

2. Install pressure regulator valve and related parts.
3. Install drive gear and shaft in pump body.
4. Install idler gear in pump body with smooth side of gear toward pump cover opening.
5. Install pump cover with new gasket and torque attaching screws to specifications.
6. Turn drive shaft by hand to check for smooth operation.

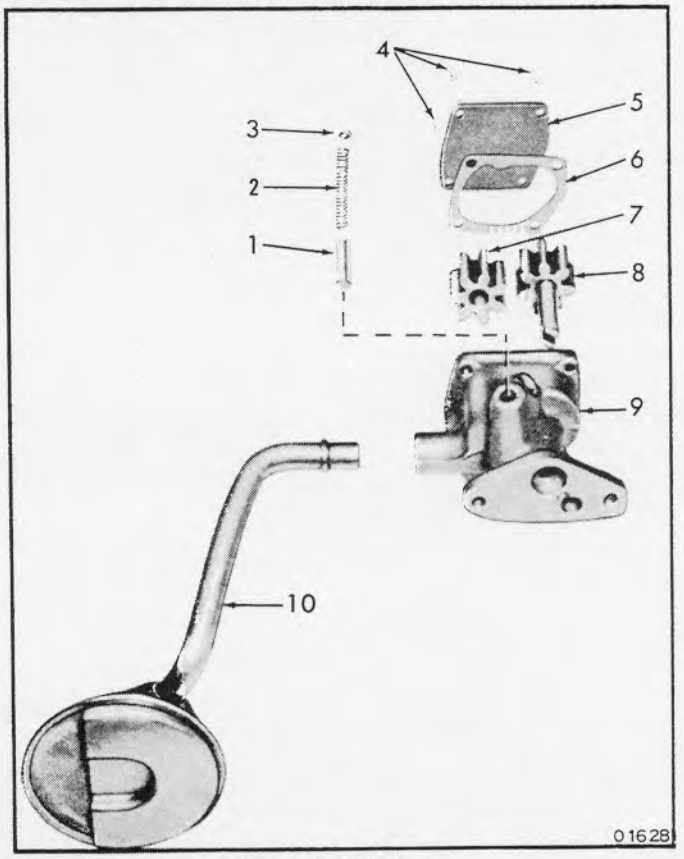


Figure 1. Oil Pump

1 Pressure Regulator Valve
2 Pressure Regulator Spring
3 Retaining Pin
4 Screws
5 Pump Cover
6 Cover Gasket
7 Idler Gear
8 Drive Gear and Shaft
9 Pump Body
10 Pickup Screen and Pipe

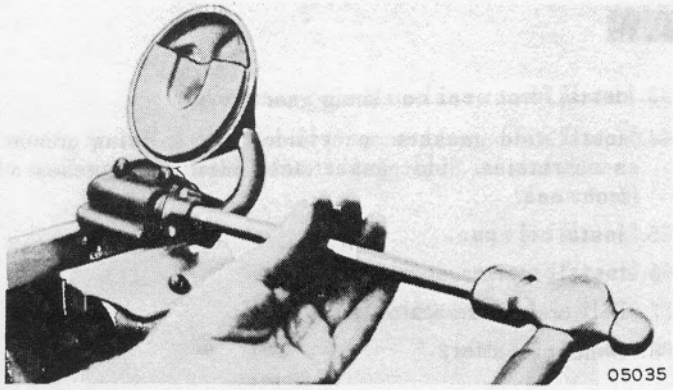


Figure 2. Installing Screen

CLEANING and INSPECTION

1. Wash all parts in cleaning solvent and dry with compressed air.
2. Inspect pump body and cover for cracks or excessive wear.
3. Inspect pump gears for damage or excessive wear.
4. Check drive gear shaft for looseness in pump body.
5. Inspect inside of pump cover for wear that would permit oil to leak past ends of gears.
6. Inspect pickup screen and pipe assembly for damage to screen, pipe or relief grommet.
7. Check pressure regulator valve for fit.

NOTE: Pump gears and body are not serviced separately. If pump gears or body are damaged or worn, replace entire oil pump assembly.

CRANKSHAFT PULLEY

REMOVAL

1. Remove front mounting bracket and drive belt. Remove crankshaft pulley from pulley hub.
2. Install puller Tool J-6978 to pulley hub with two 3/8 x 2" and one 5/16 x 2" bolts and remove hub. (Figure 1) Remove puller tool.

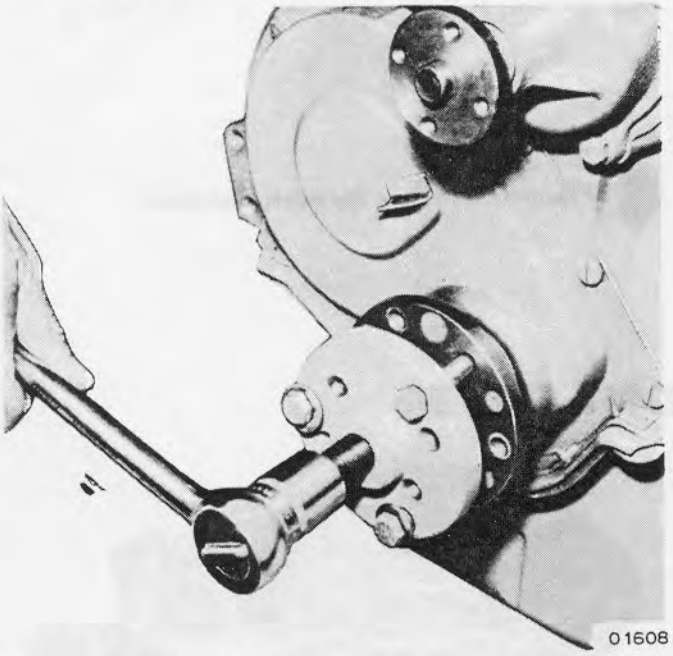


Figure 1. Removing Crankshaft Pulley Hub

INSTALLATION

1. Coat oil seal contact area on hub with engine oil, position hub over crankshaft and key and start hub into position with a mallet. Using Tool J-5590, strike hub until it bottoms against crankshaft gear.

   NOTE: Crankshaft extends slightly thru hub, and a tool is necessary to drive hub completely into bottomed position.
2. Install pulley onto hub.

   NOTE: There are two 3/8" (9.5mm) holes and one 5/16" (7.9mm) hole that must be matched on hub in order to properly position timing mark. (Figure 2)
3. Install drive belt
4. Install front mounting bracket.

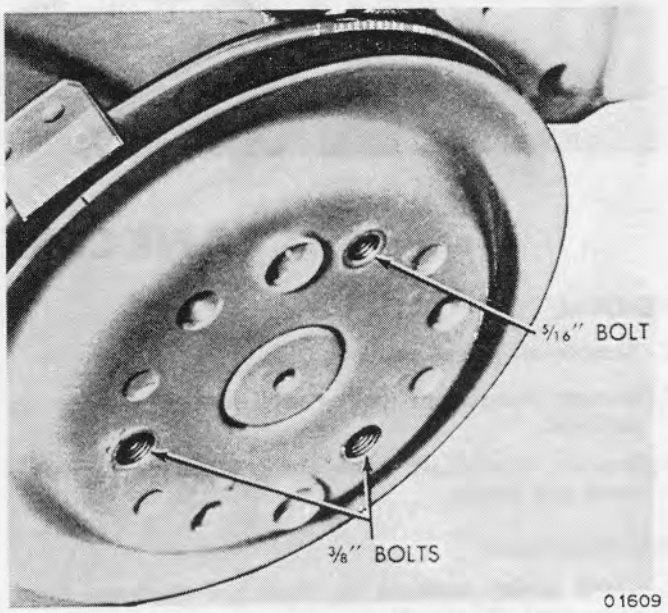


Figure 2. Install Pulley To Hub

TORSIONAL DAMPER

REMOVAL

1. Remove front mounting bracket and drive belt. Remove retaining bolt, if so equipped.
2. Install Tool J-6978 to balancer and turn puller screw to remove damper. (Figure 3) Remove tool from damper.

INSTALLATION

1. Coat front cover oil seal contact area of balancer with engine oil.
2. Attach damper installer Tool J-8792 to damper as shown in Figure 4.
3. Position damper on crankshaft and drive into position until it bottoms against crank shaft gear (except "292" model).

   (Pull "292" engine damper onto crankshaft with a fully-threaded 7/16-20 bolt, washer and nut.)
4. Remove installation tool or bolt.
5. Install drive belt and adjust tension.
6. Install front mounting bracket.

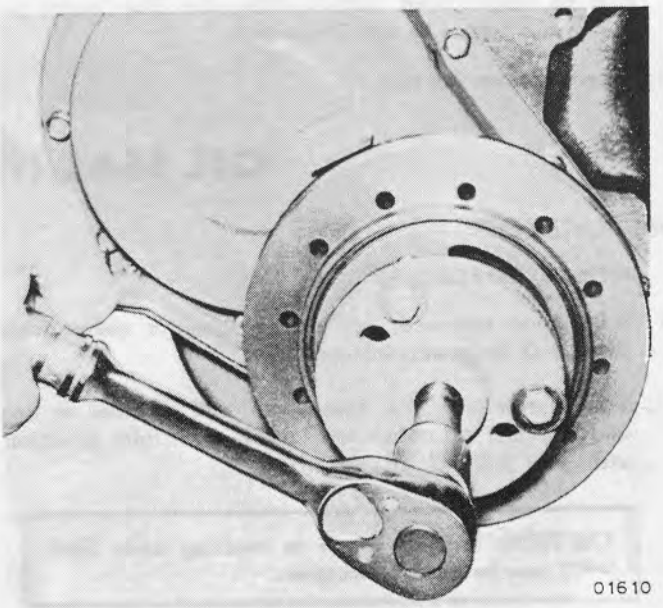
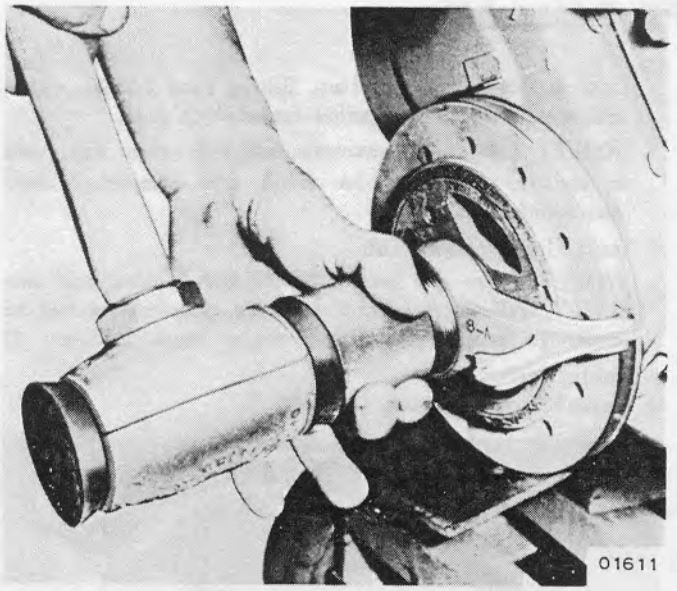


Figure 3. Removing Harmonic Balancer



CAUTION: Inertia weight section of torsional damper is assembled to hub with rubber type material. Installation procedures (with proper tool) must be followed or movement of inertia weight section on hub will upset tuning of torsional damper.

Figure 4. Installing Harmonic Balancer

CRANKCASE FRONT COVER

REMOVAL

1. Remove oil pan as outlined.
2. Remove crankshaft pulley and hub or damper as outlined.
3. Remove crankshaft front cover attaching screws, cover and gasket.

INSTALLATION

1. Clean gasket surfaces on block and crankcase front cover seal. (Figure 5)
2. Install centering Tool J-23042 in crankcase front cover seal. (Figure 5)
3. Coat gasket with gasket sealer and place in position on cover, then install crankcase front cover to block and torque to specifications.
4. Remove centering tool.

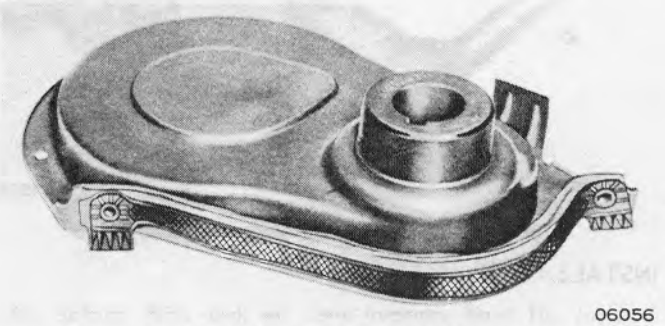


Figure 5. Centering Tool (J-23042) In Cover

NOTE: Use only centering tool to align crankcase front cover so that crankshaft hub or damper installation will not damage seal and to position seal to seal evenly around damper or hub surface.

5. Install crankshaft hub and/or damper as outlined.
6. Install oil pan as outlined.

OIL SEAL (FRONT COVER)

REPLACEMENT

WITH COVER REMOVAL

1. With cover removed, pry old seal out of cover from front with large screwdriver.
2. Install new seal so that open end of seal is toward inside of cover and drive seal into position with Tool J-23042. (Figure 6)

CAUTION: Support cover at sealing area. Tool J-971 may be used as support.

WITHOUT COVER REMOVAL

1. With crankshaft pulley and hub or damper removed, pry old seal out of cover from front with large screwdriver, being careful not do damage seal surface on crankshaft.
2. Install new seal so that open end of seal is toward inside of cover and drive seal into position with Tool J-23042. (Figure 7)

Figure 6. Installing Oil Seal (Cover Removed)

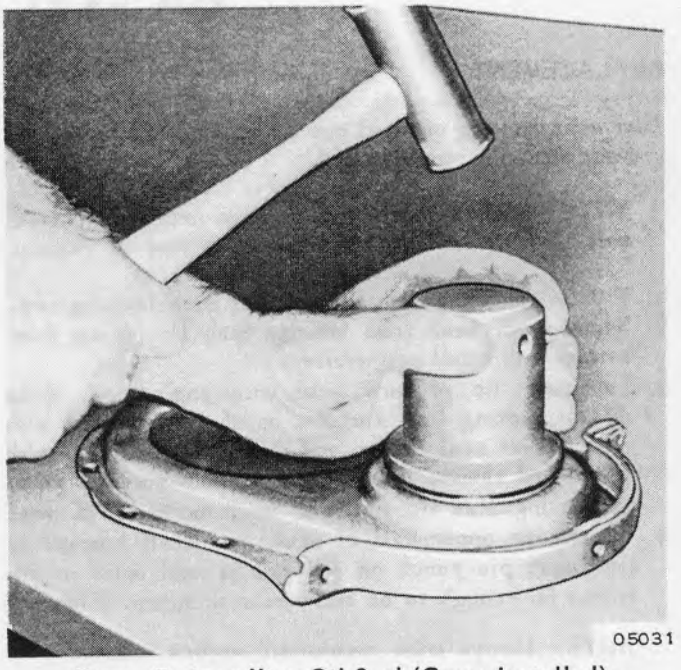


Figure 7. Installing Oil Seal (Cover Installed)

FLYWHEEL and COUPLER

REMOVAL

1. Remove engine from boat.
2. Remove bell housing.
3. Remove coupler by removing retaining nuts and washers.

INSPECTION

ENGINE COUPLING

Warranty inspection of engine coupling assemblies has indicated the following failure causes:

1. Failure of engine coupling assembly spline and/or universal splined shaft caused by insufficient lubrication at time of installation. On initial installation and whenever a stern drive unit is removed, lubricate engine coupling splines with Multipurpose Lubricant (C-92-49588). The spline mating surfaces will wear very rapidly if installed dry.
2. Hub bond, which shears or pulls loose from hub center, indicates engine drive misalignment. Align engine with correct alignment tool.

FLYWHEEL

Check flywheel ring gear for worn or missing teeth.

INSTALLATION

1. Install flywheel. Line up dowel hole in flywheel with dowel hole in crankshaft flange and set flywheel in place on studs. (Figure 8)

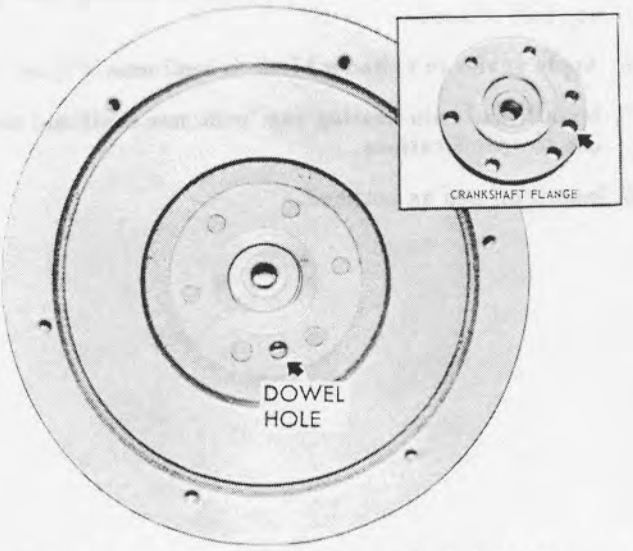


Figure 8. Flywheel Position on Crankshaft Flange

2. Place drive coupling on studs and install washers and lock nuts. Torque nuts to specifications with Torque Wrench and Adaptor (C-91-54638 for "153, 181, 230 and 250"; C-91-54638 for "292").
3. Install bell housing.
4. Lubricate coupler splines and install engine in boat.

OIL SEAL (REAR MAIN)

REPLACEMENT

Rear main bearing oil seal can be replaced (both halves) without removing crankshaft.

NOTE: Always replace upper and lower seal as a unit. Install with lip facing toward front of engine.

1. With oil pan removed, remove rear main bearing cap.
2. Remove oil seal from annular tang by prying from bottom with small screwdriver.
3. Lubricate lip of new seal with engine oil. Keep oil off parting line surface, as this is treated with glue. Insert seal in cap and roll seal into place with finger and thumb, using light pressure so seal tangs at parting line do not cut bead on back of seal.
4. To remove upper half of seal, use small hammer to tap brass pin punch on one end of seal until it protrudes far enough to be removed with pliers. (Figure 9)

NOTE: Always wipe crankshaft surface clean before installing new seal.

5. Lubricate lip of new seal with engine oil. Keep oil off parting line surface. Gradually push with a hammer handle (while turning crankshaft) until seal is rolled into place (similar to installing a main bearing). Be careful that seal tangs at parting line do not cut bead on back of seal. Use sealer at parting line on cap half of seal.
6. Apply sealer to cylinder block in seal area. (Figure 10)
7. Install rear main bearing cap (with new seal) and torque to specifications.
8. Install oil pan as outlined.

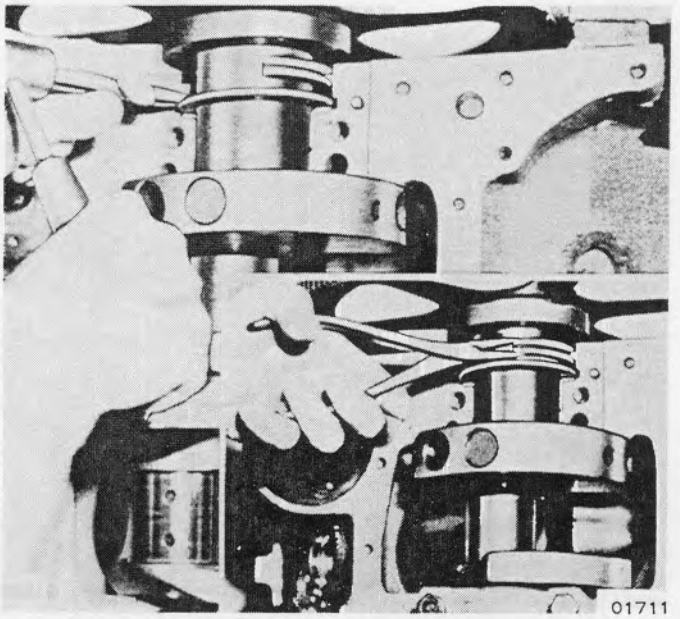


Figure 9. Removing Oil Seal (Upper Half) Typical

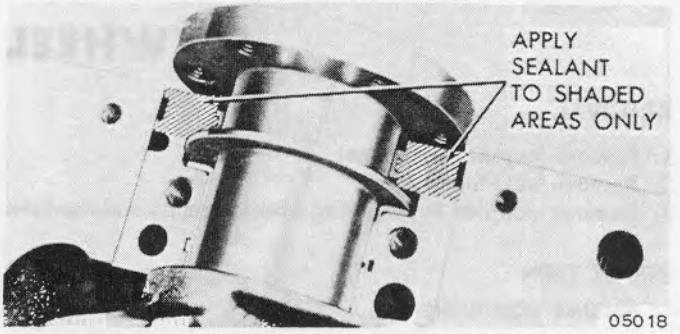


Figure 10. Sealing Bearing Cap and Block

MAIN BEARINGS

1. Main bearings are precision insert type and do not utilize shim for adjustment. If clearances are found to be excessive, a new bearing (both upper and lower halves) will be required. Bearings are available in standard size and .001", .002", .010", and .020" undersize. (1" = 25.4mm)
2. Selective fitting of both rod and main bearing inserts is necessary in production to obtain close tolerances. For example, one half of a standard insert with one half of a .001" undersize insert may be found, which will decrease clearance .0005" from using a full standard bearing.
3. When a production crankshaft cannot be precision fitted by this method, it then is ground .009" undersize on main journals only. A .009" undersize bearing and .010" undersize bearing may be used for precision fitting in same manner as previously described. Any engine, fitted with a .009" undersize crankshaft, will be identified by following markings.
   - ".009" will be stamped on crankshaft counterweight forward of center main journal.
   - Figure "9" will be stamped on block at left front oil pan rail.

NOTE: If main bearing caps are replaced, shimming may be necessary. Laminated shims for each cap are available for service. Shim requirement will be determined by bearing clearance.

INSPECTION

In general (except No. 1 bearing), lower half of bearing shows greater wear and most distress from fatigue. If, upon inspection, lower half is acceptable, it can be assumed that upper half also is satisfactory. If lower half shows evidence of wear or damage, replace both upper and lower halves. Never replace one half without replacing other half. Typical bearing failures are shown in Figure 1, following.

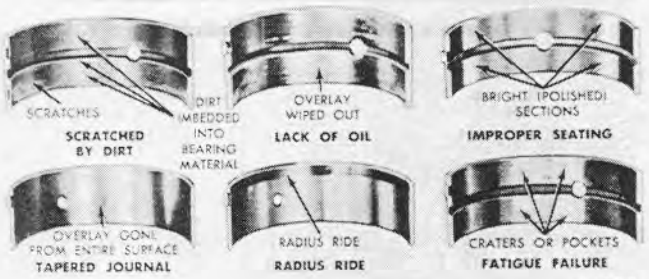


Figure 1. Typical Bearing Failure

CHECKING CLEARANCE

To obtain most accurate results, use Plastigage (or its equivalent), a wax-like plastic material which will compress evenly between bearing and journal surfaces without damaging either surface.

With engine upside down, crankshaft will rest on upper bearings and total clearance can be measured between lower bearing and journal.

NOTE: To assure proper seating of crankshaft, torque all bearing cap bolts as specified. In addition, before checking fit of bearings, wipe surface of crankshaft journal and bearing clean of oil.

1. With oil pan and oil pump removed, and starting with rear main bearing, remove bearing cap and wipe oil from journal and bearing cap.
2. Place piece of gauging plastic the full width of bearing (parallel to crankshaft) on journal. (Figure 2)

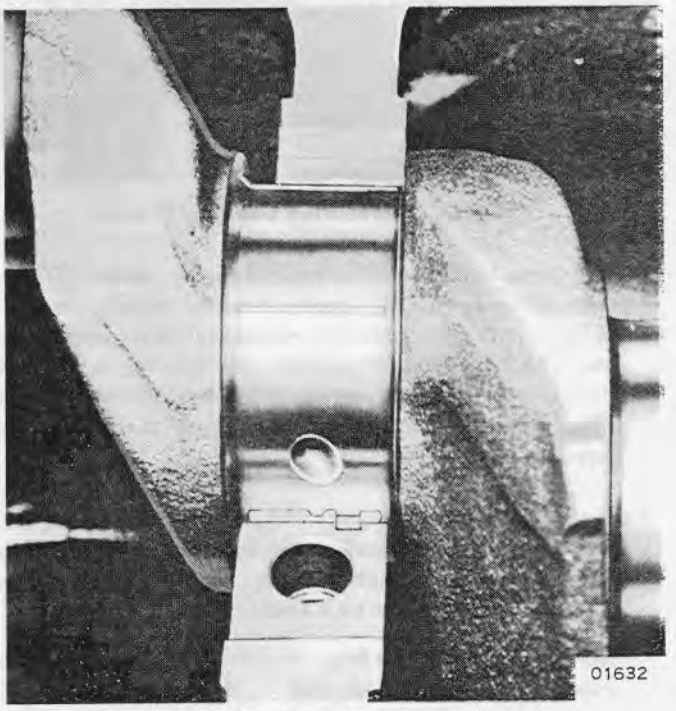


Figure 2. Gauging Plastic on Journal

CAUTION: Do not rotate crankshaft while the gauging plastic is between bearing and journal.

3. Install bearing cap and evenly torque retaining bolts to specifications.
4. Remove bearing cap. Flattened gauging plastic will be found adhering to either bearing shell or journal.
5. A graduated scale (correlated in thousandths of an inch) exists on edge of gauging plastic envelope. Without removing gauging plastic, measure its compressed width (at widest point) with graduations on gauging plastic envelope. (Figure 3)

NOTE: Normally, main bearing journals wear evenly and are not out-of-round. However, if a bearing is being fitted to an out-of-round journal (.001" [.025mm] max.), be sure to fit to maximum diameter of journal. If bearing is fitted to minimum diameter, and journal is out-of-round .001", interference between bearing

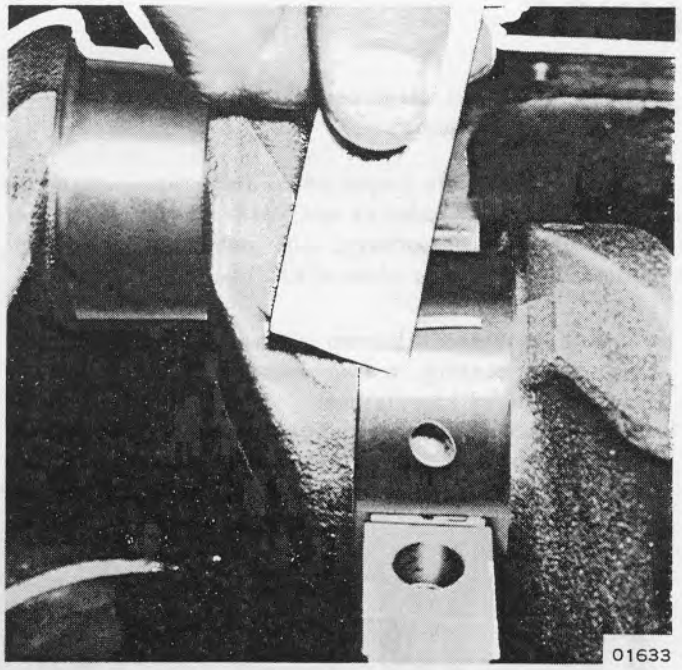


Figure 3. Measuring Gauging Plastic

and journal will result in rapid bearing failure. If flattened gauging plastic tapers toward middle or ends, there is a difference in clearance indicating taper, low spot or other irregularity of bearing or journal. Be sure to measure journal with a micrometer if flattened gauging plastic indicates more than .001" difference.

6. If bearing clearance is within specifications, bearing insert is satisfactory. If clearance is not within specifications, replace insert. Always replace both upper and lower insert as a unit.

   NOTE: If a new bearing cap is being installed and clearance is less than .001", inspect for burrs or nicks. If none is found, install shims as required.

7. A standard .001" or .002" undersize bearing may produce proper clearance. If not, regrind crankshaft journal for use with next undersize bearing.
8. Proceed to next bearing. After all bearings have been checked, rotate crankshaft so that no excessive drag exists.
9. Measure crankshaft end play (see specifications) by forcing crankshaft to extreme front position. Measure at front end of rear main bearing with feeler gauge. (Figure 4)
10. Install new rear main bearing oil seal in cylinder block and main bearing cap.

MAIN BEARING REPLACEMENT

1. Remove and inspect crankshaft.
2. Remove main bearings from cylinder block and main bearing caps.
3. Coat bearing surfaces of new, correct-size, main bearings with oil and install in cylinder block and main bearing caps. Check clearance outlined.
4. Install crankshaft.

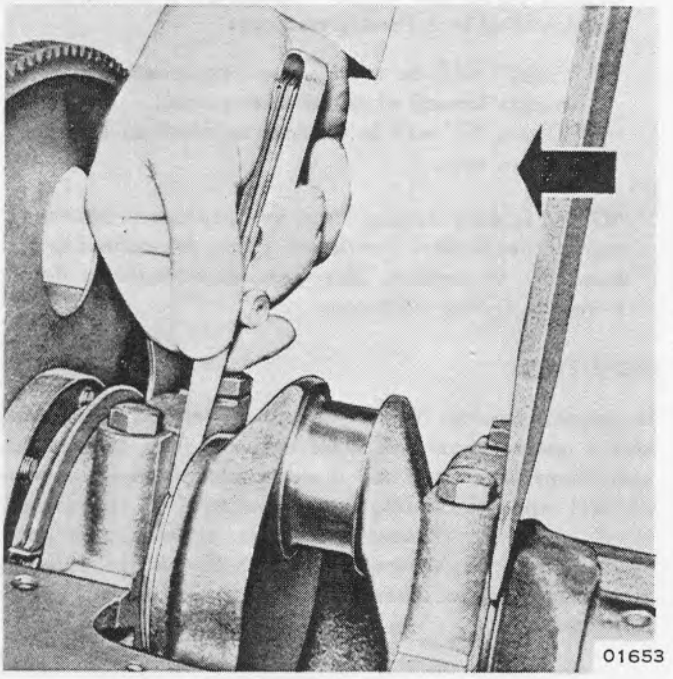


Figure 4. Measuring Crankshaft End Play

CONNECTING ROD BEARINGS

Connecting rod bearings are precision insert type and do not utilize shims for adjustment. DO NOT FILE RODS OR ROD CAPS. If clearances are found to be excessive, a new bearing will be required. Bearings are available in standard size and .001" and .002" undersize for use with new and used standard size crankshaft and in .010" and .020" undersize for use with reconditioned crankshafts. (1" = 25.4mm)

INSPECTION and REPLACEMENT

1. With oil pan and oil pump removed, remove connecting rod cap and bearing.
2. Inspect bearing for evidence of wear or damage. (Defective bearings should not be installed.) Typical bearing failures are shown in Figure 1, preceding.
3. Wipe bearings and crankpin clean of oil.
4. Measure crankpin for out-of-round or taper with a micrometer. If not within specifications, replace or recondition crankshaft. If within specifications and new bearing is to be installed, measure maximum diameter of crankpin to determine new bearing size required.
5. If within specifications, measure new or used bearing clearances with Plastigage or equivalent.

   NOTE: If bearing is being fitted to out-of-round crankpin, be sure to fit maximum diameter of crankpin. If bearing is fitted to minimum diameter, and crankpin is out-of-round .001", interference between bearing and crankpin will result in rapid bearing failure.

   a. Place a piece of gauging plastic the full width of crankpin (parallel to crankshaft). (Figure 5)
   b. Install bearing connecting rod and cap.
   c. Install bearing cap and torque nuts evenly to specifications.

CAUTION: Do not turn crankshaft with gauging plastic installed.

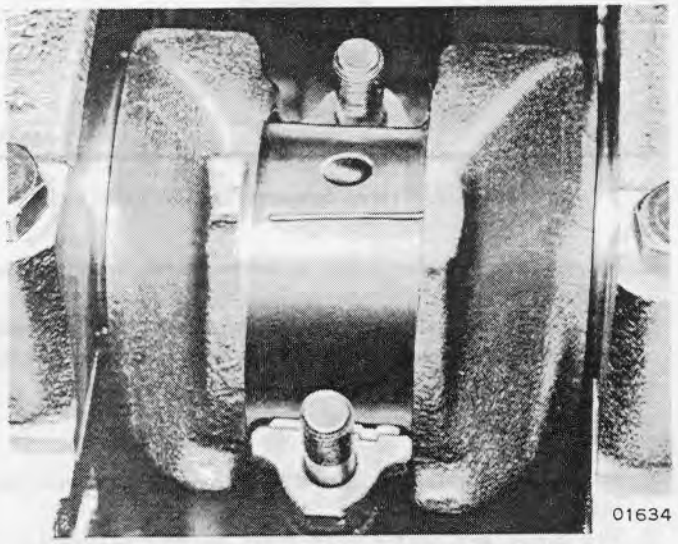


Figure 5. Gauging Plastic on Crankpin

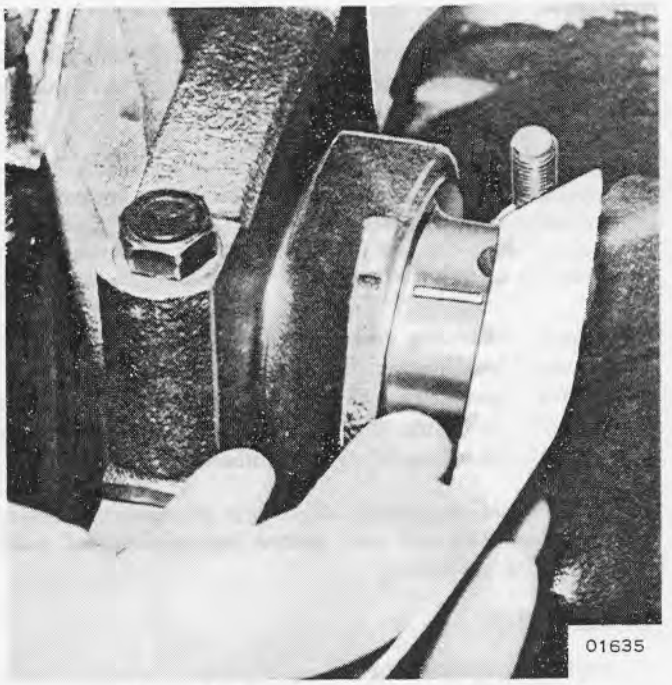


Figure 6. Measuring Gauging Plastic

   d. Remove bearing cap and, using scale on gauging plastic envelope, measure gauging plastic width at widest point. (Figure 6)
6. If clearance exceeds specifications, select a new, correct-size bearing and remeasure clearance.
7. Coat bearing surface with oil, install rod cap and torque nuts to specifications.
8. When all connecting rod bearings have been installed, tap each rod lightly (parallel to crankpin) to be sure they have clearance.
9. Measure all connecting rod side clearances (see specifications) between connecting rod and side of crankpin. (Figure 7)

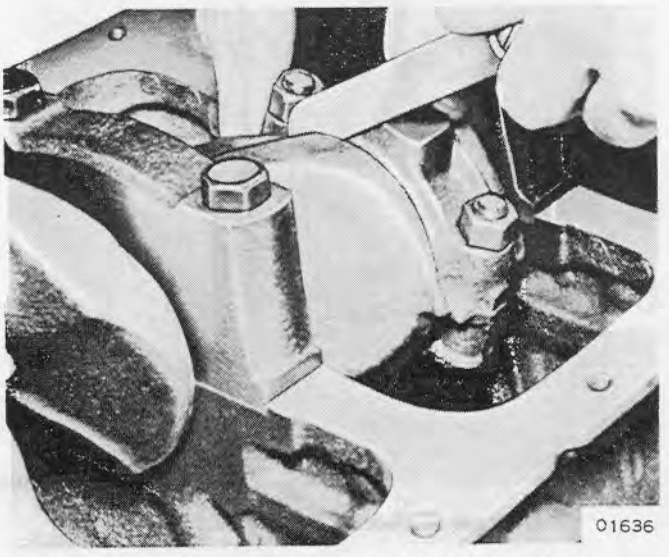


Figure 7. Measuring Connecting Rod Side Clearance

CONNECTING ROD and PISTON ASSEMBLIES

REMOVAL

1. With oil pan, oil pump and cylinder head removed, use a ridge reamer to remove any ridge and/or deposits from upper end of cylinder bore.

   NOTE: Before ridge and/or deposits are removed, turn crankshaft until piston is at bottom of stroke and place a cloth on top of piston to collect cuttings. After ridge and/or deposits are removed, turn crankshaft until piston is at top of stroke and remove cloth and cuttings.

2. Inspect connecting rods and connecting rod caps for cylinder identification. If necessary, mark them.
3. Remove connecting rod cap and install Tool J-6305 (11/32") on bolts. Push connecting rod and piston assembly out of top of cylinder block. (Figure 1)

   NOTE: Turn crankshaft slightly to disconnect some of the connecting rod and piston assemblies and push them out of cylinder.

DISASSEMBLY

PISTON SUPPORT TOOL

If bosses on pistons do not allow piston support Tool J-9510-1 to seat squarely on piston for press operations, modifications to tool are necessary. To allow adequate clearance for these bosses, turn or grind upper portion of tool to dimensions shown in Figure 2.

Installation of 181 cubic inch pistons may require additional grinding of support tool beyond dimensions shown in Figure 2.

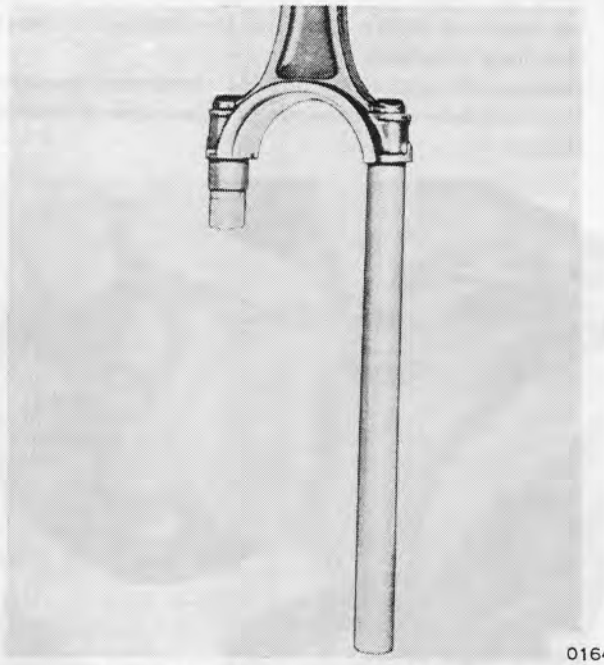


Figure 1. Guide Tool J-6305 Installed

Modification of tool as described does not affect tool application on other pistons.

1. Remove connecting rod bearings from connecting rods and caps.

   NOTE: If connecting rod bearings are being reused, place in a rack for reinstallation in original rod and cap.

2. Use piston ring expander to expand rings and slide from pistons.
3. Place connecting rod and piston assembly in arbor press with piston on support Tool J-9510-1 and press piston pin out of connecting rod and piston.
4. Remove assembly from arbor press and remove tools, piston pin, connecting rod and piston.

CLEANING and INSPECTION

CONNECTING RODS

1. Wash connecting rods in cleaning solvent and dry with compressed air.
2. Check for twisted or bent rods and inspect for nicks or cracks. Replace damaged connecting rods.

PISTONS

1. Clean varnish from piston skirts and pins with cleaning solvent. DO NOT WIRE BRUSH ANY PART OF PISTON. Clean ring grooves with groove cleaner and make sure oil ring holes and slots are clean.
2. Inspect piston for cracked ring lands, skirts or pin bosses, wavy worn ring lands, scuffed or damaged skirts and eroded areas at top of piston. Replace pistons which are damaged or show signs of excessive wear.

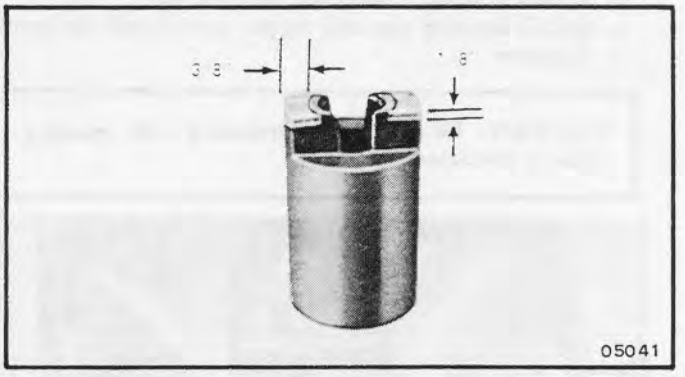


Figure 2. Piston Support Tool J-9510-1

3. Inspect grooves for nicks or burrs which might cause rings to hang up.
4. Measure piston skirt (across centerline of piston pin) and check clearance as outlined under "Piston Selection".

PISTON PINS

1. Piston and piston pin are a matched set and not serviced separately.
2. Pin bores and piston pins must be free of varnish or scuffing. Measure piston pin with a micrometer and piston pin bore with a dial bore gauge or inside micro-

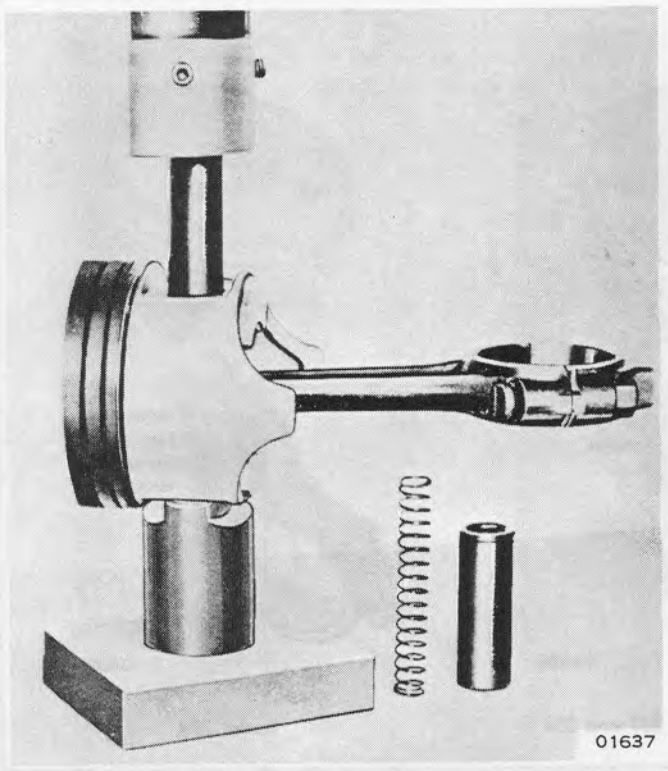


Figure 3. Removing Piston Pin

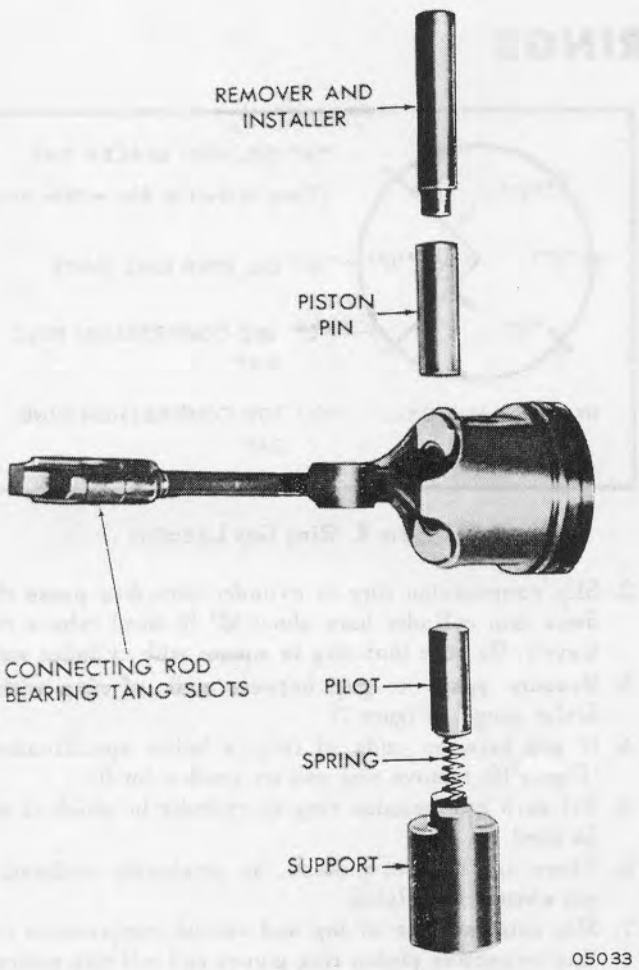


Figure 4. Piston Pin Installation

meter. If clearance is in excess of .001" (.025mm) wear limit, replace piston and piston pin assembly.

REASSEMBLY

1. Lubricate piston pin holes in piston and connecting rod for easier pin installation.
2. Place support Tool J-9510-1 with spring and pilot in place on arbor press.
3. Position piston on connecting rod with appropriate side of piston and connecting rod bearing tangs aligned. (Figure 4)
4. Place piston on support, indexing pilot through piston and rod.
5. Place installer (Figure 4) on piston pin, start piston and press on installer until pilot bottoms in support.
6. Remove installer from connecting rod and piston assembly and check piston for freedom of movement on piston pin. (Figure 6)

NOTE: An oven is recommended to heat small end of connecting rod prior to installation in piston assembly. (Figure 5)

Figure 5. Piston Pin Oven

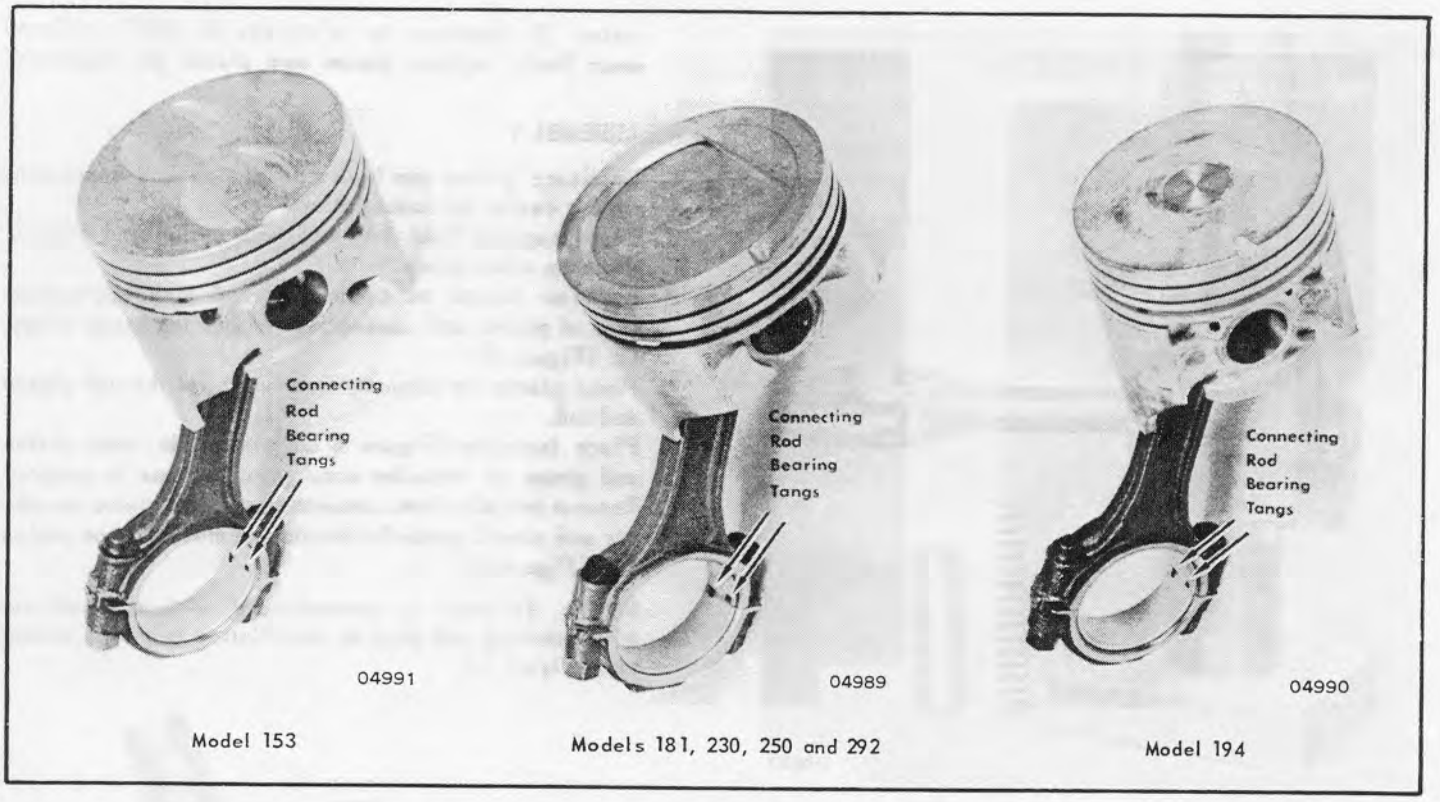


Figure 6. Connecting Rod and Piston Assembly

PISTON RINGS

All compression rings are marked on upper side of ring. When installing compression rings, make sure marked side is toward top of piston. Top ring is chrome faced or treated with molvbdenum for maximum life. Oil control rings are 3-piece type, consisting of 2 segments (rails) and a spacer.

1. Select rings comparable in size to piston being used.

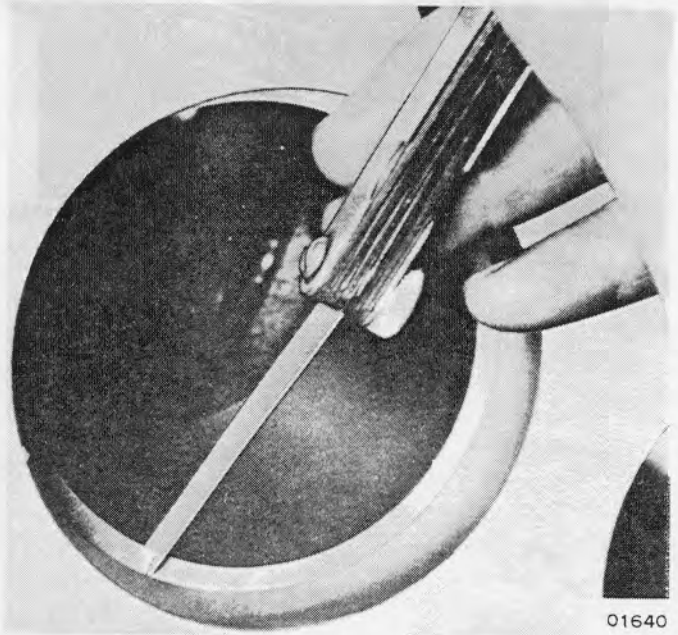


Figure 7. Measuring Ring Gap

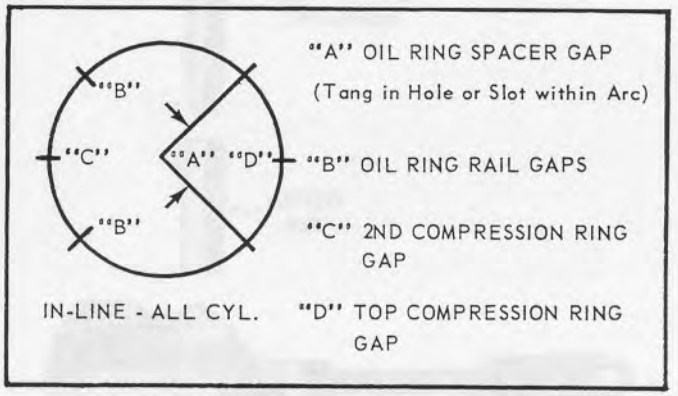


Figure 8. Ring Gap Location

2. Slip compression ring in cylinder bore, then press ring down into cylinder bore about ¼" (6.4mm) (above ring travel). Be sure that ring is square with cylinder wall.
3. Measure space or gap between ends of ring with a feeler gauge. (Figure 7)
4. If gap between ends of ring is below specifications (Figure 8), remove ring and try another for fit.
5. Fit each compression ring to cylinder in which it will be used.
6. Clean and inspect pistons, as previously outlined, if not already completed.
7. Slip outer surface of top and second compression ring into respective piston ring groove and roll ring entirely around groove (Figure 9) to make sure that ring is free. If binding occurs at any point, determine cause and,

if caused by ring groove, remove by dressing with a fine cut file. If binding is caused by a distorted ring, check a new ring.

8. Install piston rings as shown in Figure 6. Ring installation tools are:

MODEL	TOOL NO.
153, 230, 250, 292	J-8021 (3 7/8")
181	J-8032 (4")
194	J-8020 (3 9/16")

   a. Install oil ring spacer in groove and (except on 250) insert anti-rotation tang in oil hole.
   b. Hold spacer ends butted and install lower steel oil ring rail with gap properly located.
   c. Install upper steel oil ring rail with gap properly located.
   d. Flex oil ring assembly to make sure that ring is free. If binding occurs at any point, determine cause and, if caused by ring groove, remove by dressing groove with a fine cut file. If binding if caused by a distorted ring, check a new ring.
   e. Install second compression ring expander, then ring with gaps properly located.
   f. Install top compression ring with gap in correct location.

9. Proper clearance of piston ring in piston ring groove is necessary for proper ring action and to reduce wear. Therefore, when fitting new rings, measure clearances between ring surfaces and groove. (See "Specifications", Section 8.)

INSTALLATION

NOTE: Cylinder bores must be clean before piston installation. Clean with hot water and detergent wash or with a light honing, as necessary. After cleaning, swab bores several times with light engine oil and a clean dry cloth.

1. Lubricate connecting rod bearings and install in rods and rod caps.
2. Lightly coat pistons, rings and cylinder walls with light engine oil.
3. With bearing caps removed, install Tool J-6305(11/32") on connecting rod bolts.

CAUTION: Be sure that ring gaps are properly positioned as previously outlined.

NOTE: Early Model "181" No. 2 connecting rods have a ground recess on camshaft side to provide clearance for fuel pump lobe on camshaft. Be sure that No. 2 connecting rod is installed in same location and and position. If connecting rod is replaced, then replace camshaft also, since replacement connecting rods are not ground for clearance, and replacement camshafts have a smaller fuel pump lobe.

4. Install each connecting rod and piston assembly in respective bore. Pistons must have piston notch facing front of engine. Use Tool J-8307 to compress rings. (Figure 10) Guide connecting rod into place on crankshaft journal with Tool J-5239. Use light blows with hammer handle to install piston into bore. Hold ring compressor firmly against cylinder block until all piston rings have entered cylinder bore.
5. Remove guide tool.
6. Install bearing caps and torque nuts to specification.

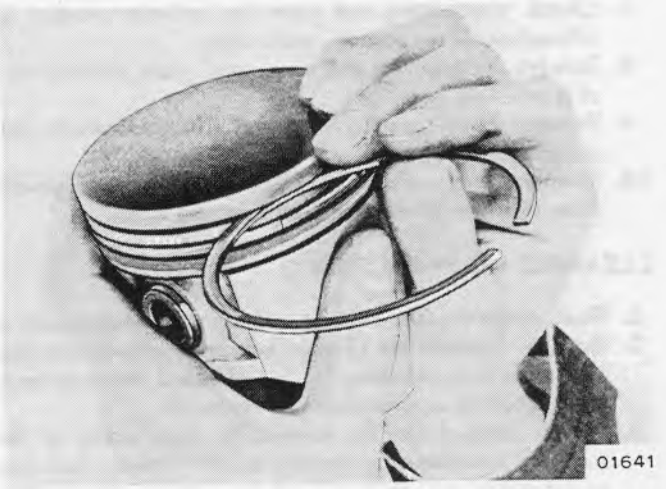


Figure 9. Checking Ring in Groove

NOTE: If bearing replacement is required, refer to "Connecting Rod Bearings", preceding.

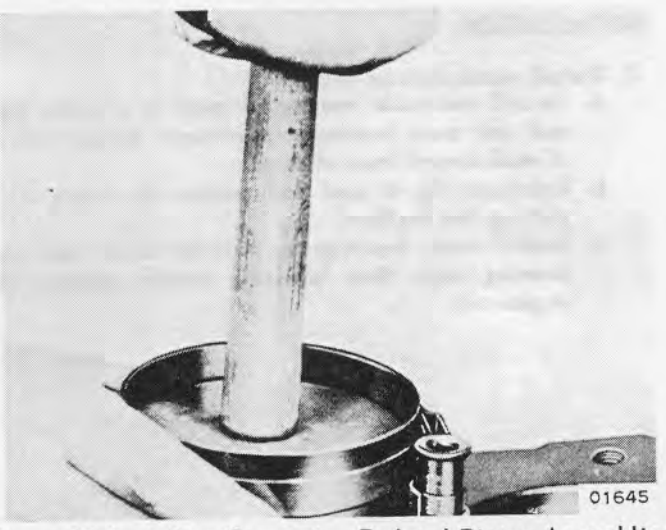


Figure 10. Installing Connecting Rod and Piston Assemblies

NOTE: Be sure to install new pistons in same cylinders for which they were fitted and used pistons in same cylinders from which they were removed. Each connecting rod and bearing cap should be marked, beginning at front of engine.

CRANKSHAFT

Crankshaft can be removed while engine is disassembled for overhaul or without complete disassembly.

REMOVAL

1. Remove flywheel housing, coupler and flywheel.
2. Remove starter motor.
3. Remove spark plugs.
4. Remove crankshaft pulley or torsional damper.
5. Remove oil pan and oil pump.
6. Remove crankcase front cover.
7. Check connecting rod caps for cylinder number identification. If necessary, mark caps.
8. Remove connecting rod caps and push pistons to top of bores.
9. Remove main bearing caps and lift crankshaft out of cylinder block.
10. Remove rear main bearing oil seal and main bearings from cylinder block and main bearing caps.

CLEANING and INSPECTION

1. Wash crankshaft in solvent and dry with compressed air.
2. Measure dimensions of main bearing journals and crankpins with a micrometer for out-of-round, taper or undersize (see "Specifications", Section 8).
3. Check crankshaft for run-out by supporting at front and rear main bearing journals in "V" blocks and check at front and rear intermediate journals with a dial indicator (see "Specifications").
4. Replace or recondition crankshaft if not within specifications.

INSTALLATION

1. Install crankshaft as follows:
   a. Install rear main bearing oil seal in cylinder block and rear main bearing cap grooves. Install with lip of seal toward front of engine.
   b. Lubricate lip of seal with engine oil. Keep oil off parting line surface.
   c. Install main bearings in cylinder block and main bearing caps, then lubricate bearing surface with engine oil.

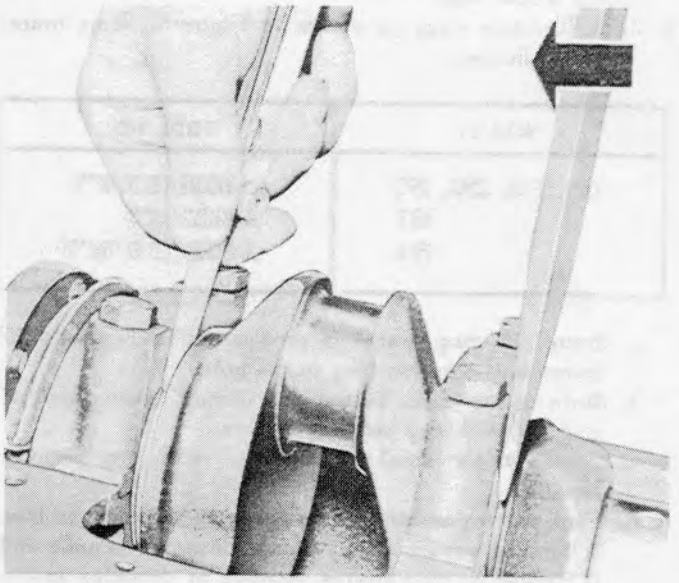


Figure 1. Measuring Crankshaft End Play

   d. Install crankshaft, being careful not to damage bearing surfaces.
   e. Apply a thin coat of brush-on type oil sealing compound to block mating surface and corresponding surface of cap only. Do not allow sealer on crankshaft or seal lip.
   f. Install main bearing caps with arrows pointing toward front of engine.
   g. Torque all except rear main bearing cap bolts to specifications. Torque rear main bearing cap bolts to specifications, then tap end of crankshaft, first from rear then forward, with a lead hammer. This will line up rear main bearing and crankshaft thrust surfaces. Retorque all main bearing cap bolts to specifications.
   h. Measure crankshaft end play with a feeler gauge. Force crankshaft forward and measure clearance between front of rear main bearing and crankshaft thrust surface. (Figure 1)
2. Install flywheel as outlined and torque to specifications.

CAMSHAFT

MEASURING LOBE LIFT

NOTE: Procedure is similar to checking valve timing. If improper valve operation is indicated, measure lift of each push rod in consecutive order and record the readings.

1. Remove valve mechanism as outlined.
2. Position indicator with ball socket adaptor (Tool J-8520) on push rod. (Figure 2)
3. Rotate torsional damper slowly in direction of rotation until lifter is on heel of cam lobe. At this point, push rod will be in its lowest position.
4. Set dial indicator on zero, then rotate damper slowly, or attach an auxiliary starter switch and "bump" engine over, until push rod is in fully raised position.

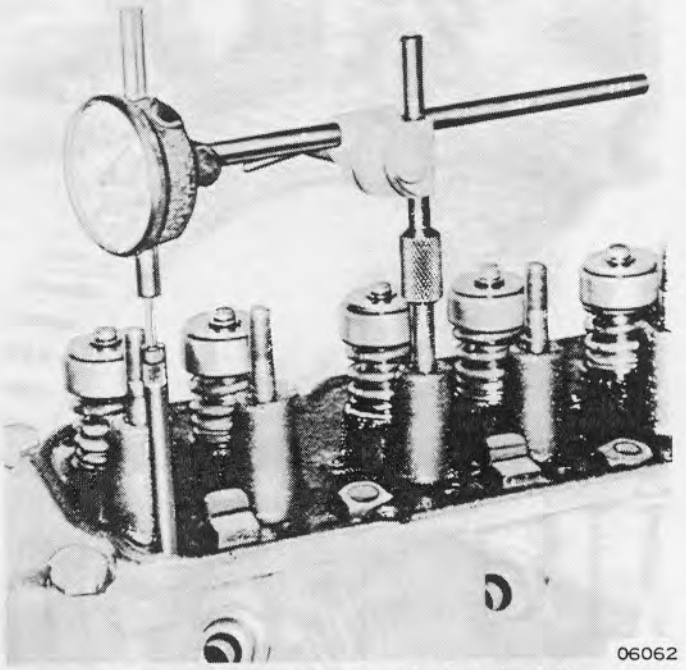


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Figure 2. Measuring Camshaft Lobe Lift

5. Compare total lift recorded from dial indicator with "Specifications", Section 8.
6. Continue to rotate crankshaft until indicator reads zero. This will be a check on accuracy of original indicator reading.
7. If camshaft readings for all lobes are within specifications, remove dial indicator assembly.
8. Install and adjust valve mechanism as outlined.

REMOVAL

1. Remove valve lifters as outlined.
2. Remove crankcase front cover as outlined.
3. Remove fuel pump as outlined.
4. Align timing gear marks, then remove 2 camshaft thrust plates' screws by working thru holes in camshaft gear. (Figure 3)
5. Pull camshaft and gear assembly out thru front of block.

NOTE: Support camshaft carefully when removing to protect camshaft bearings.

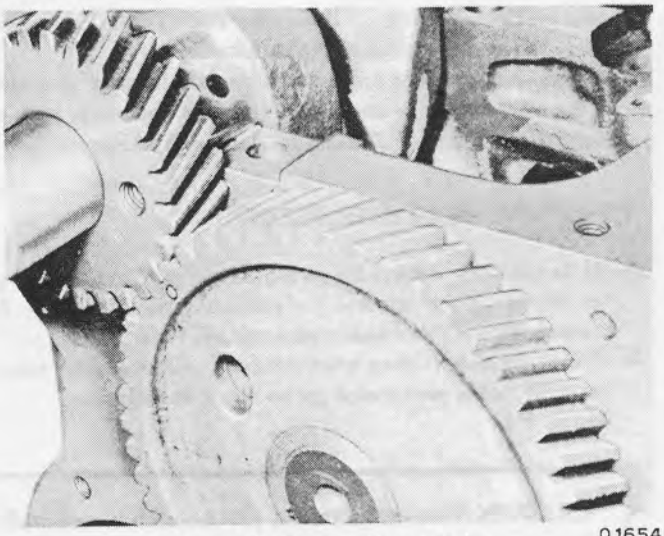

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Figure 3. Timing Gear Marks

INSPECTION

1. Measure camshaft bearing journals with a micrometer for out-of-round condition. If journals exceed .001" (.025mm) out-of-round, replace camshaft.

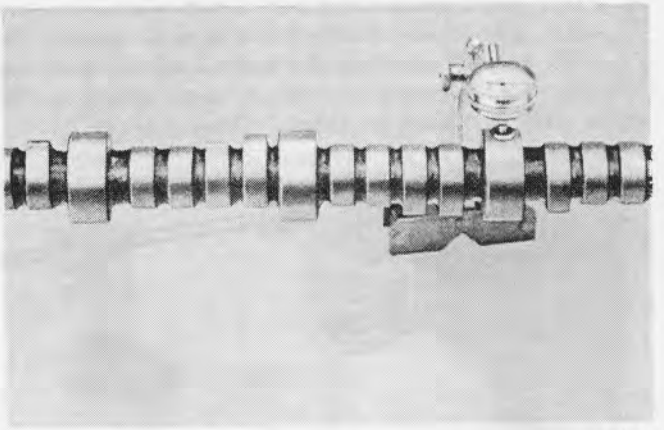

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Figure 4. Checking Camshaft Alignment

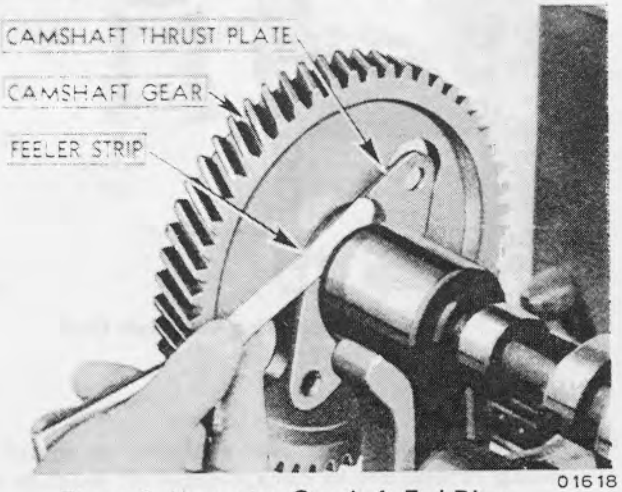

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Figure 5. Measuring Camshaft End Play

2. Check camshaft for alignment with "V" blocks and dial indicator (Figure 4) for exact amount that camshaft is out-of-true. If out more than .002" (.051mm) dial indicator reading, replace camshaft.
3. On in-line engines, inspect camshaft gear and thrust plate for wear or damage. Measure camshaft end play (.001" to .005" [.025mm to .127mm]). (Figure 5)

CAMSHAFT GEAR REPLACEMENT

1. If inspection (preceding) indicated that camshaft, gear or thrust plate should be replaced, remove gear from camshaft with camshaft gear remover Tool J-971.
2. Place camshaft thru gear remover, place end of remover on table of a press and press shaft out of gear. (Figure 6)

CAUTION: Position thrust plate so that woodruff key in shaft does not damage plate when shaft is pressed out of gear. Also support hub of gear, or gear will be seriously damaged.

3. To assemble camshaft gear, thrust plate and gear spacer ring to camshaft, firmly support camshaft at back of front journal in arbor press.
4. Place gear spacer ring and thrust plate over end of shaft, and install woodruff key in shaft keyway. Press shaft gear onto shaft until it bottoms against gear spacer ring. End clearance of thrust plate should be .001" to .005" (.025mm to .127mm). (Figure 5)

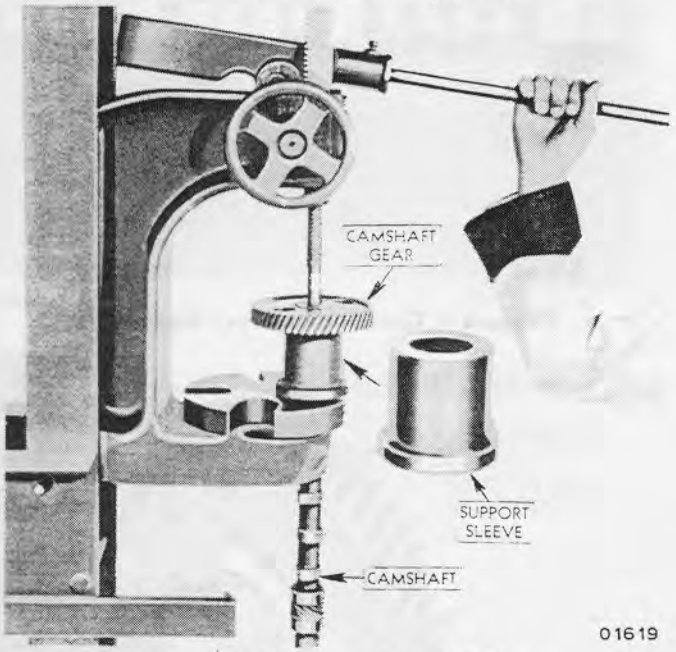

Figure 6. Removing Camshaft Gear

INSTALLATION

1. Install camshaft and gear assembly in engine block, being careful not to damage camshaft bearings or camshaft.
2. Turn crankshaft and camshaft so that valve timing marks on gear teeth will line up. (Figure 7) Push camshaft thrust plate to block screws and torque to specifications.
3. Check camshaft and crankshaft gear run-out with a dial indicator. (Figure 8) Camshaft gear run-out should not exceed .004" (.102mm) and crankshaft gear run-out should not exceed .003" (.076mm).
4. If gear run-out is excessive, remove gear and clean burrs from shaft, or gear must be replaced.
5. Check backlash between timing gear teeth with a dial indicator. (Figure 9) Backlash should not be less than .004", nor more than .006" (.152mm).
6. Install fuel pump as outlined.
7. Install crankcase front cover as described.
8. Install valve lifters as outlined.

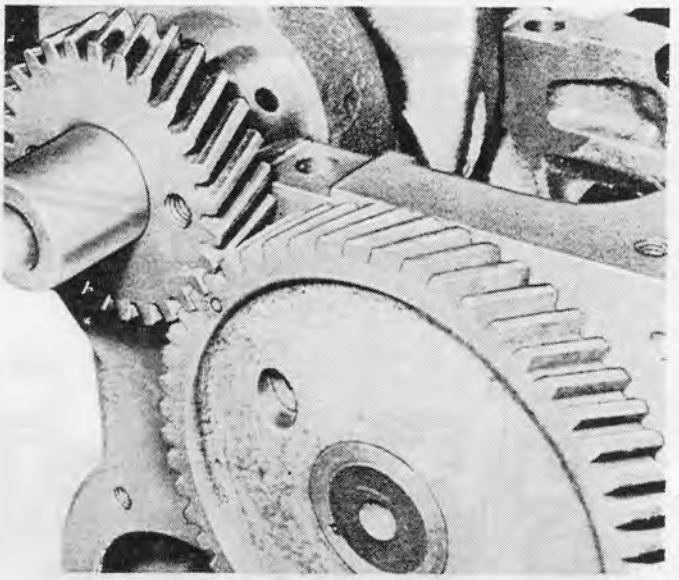

Figure 7. Crankshaft Gear

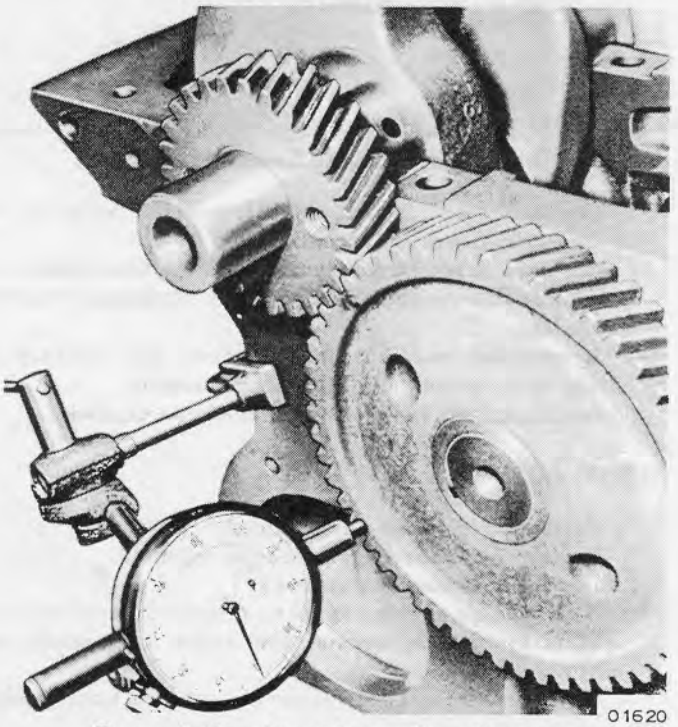

Figure 8. Checking Timing Gear Run-Out

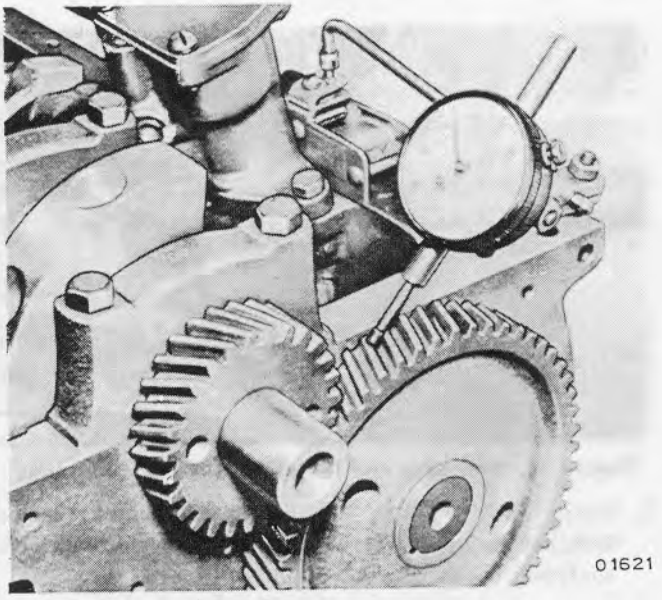

Figure 9. Checking Timing Gear Backlash

CAMSHAFT BEARINGS

REMOVAL

With camshaft removed, inspect bearings for evidence of wear or damage. Replace defective bearings.

Replace camshaft bearings while engine is disassembled for overhaul or without complete disassembly of the engine. To replace bearings without complete disassembly, remove camshaft and crankshaft, leaving cylinder heads attached and pistons in place. Before removing crankshaft, tape threads of connecting rod bolts to prevent damage to crankshaft. Fasten connecting rods against sides of engine so that rods will not hinder camshaft bearing replacement.

1. With camshaft and crankshaft removed, drive camshaft rear plug from cylinder block.

   NOTE: This procedure is based on removal of bearings nearest center of engine first. Thus, a minimum number of turns are necessary to remove all bearings.

2. Using Tool Set J-6098, with nut then thrust washer installed to end of threads, position pilot in front camshaft bearing and install puller screw thru pilot.
3. Install remover and installer tool with shoulder toward bearing, making sure a sufficient amount of threads are engaged.
4. Using 2 wrenches, hold puller screw while turning nut. When bearing has been pulled from bore, remove tool and bearing from puller screw. (Figure 10)
5. Remove remaining bearings (except front and rear) in same manner. Position pilot in rear camshaft bearing to remove rear intermediate bearing.
6. Assemble remover and installer tool on driver handle and remove front and rear camshaft bearings by driving toward center of cylinder block. (Figure 11)

INSTALLATION

Install front and rear camshaft bearings first. These bearings will act as guides for pilot and center remaining bearings being pulled into place.

NOTE: Bearing O.D.'s for 6-cylinder (Nos. 1 and 4) and 4-cylinder (No. 3) are 2.009-2.011 and 6-cylinder (Nos. 2 and 3) and 4-cylinder (Nos. 1 and 2) are 1.999-2.001.

1. Assemble remover and installer tool on driver handle and install front and rear camshaft bearings by driving toward center of cylinder block. (Figure 11)

CAUTION: Oil holes in bearings must line up with oil holes in cylinder block. Oil hole is on top side of bearing shell and cannot be seen during installation, so first align bearing shell oil hole with oil hole in bore and mark opposite side of bearing and block at bore to easily position oil hole during installation.

NOTE: Front bearing must be driven approximately 1/8" behind front of cylinder block to uncover oil hole to timing gear oil nozzle.

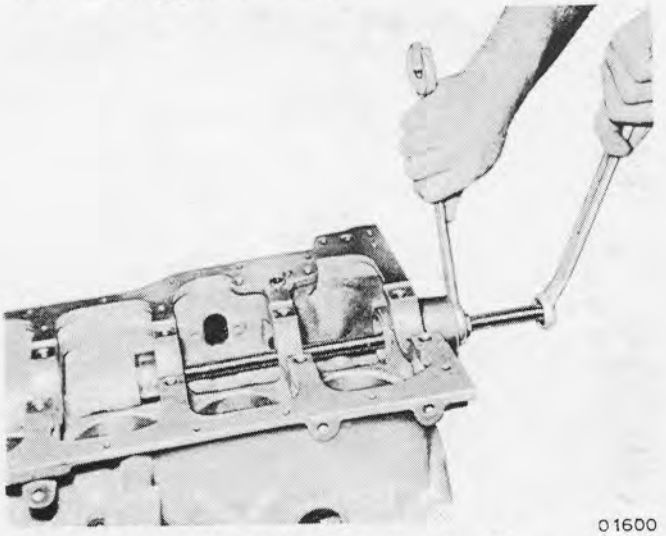

Figure 10. Pulling Bearing from Bore

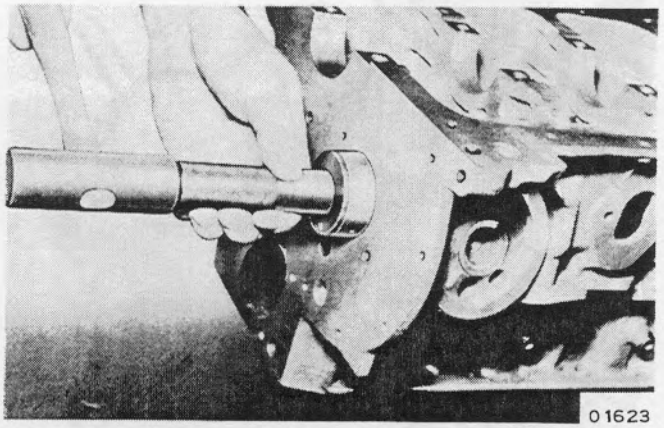
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Figure 11. Removing and Installing Camshaft Bearings

2. Using Tool Set J-6098, with nut then thrust washer installed to end of threads, position pilot in front camshaft bearing and install puller screw thru pilot.
3. Index camshaft bearing in bore, then install remover and installer tool on puller screw with shoulder toward bearings.
4. Using 2 wrenches, hold puller screw while turning nut. After bearing has been pulled into bore, remove tool from puller screw and check alignment of oil hole in camshaft bearing. (Figure 10)
5. Install remaining bearings in same manner. Position pilot in rear camshaft bearing to install rear intermediate bearing.

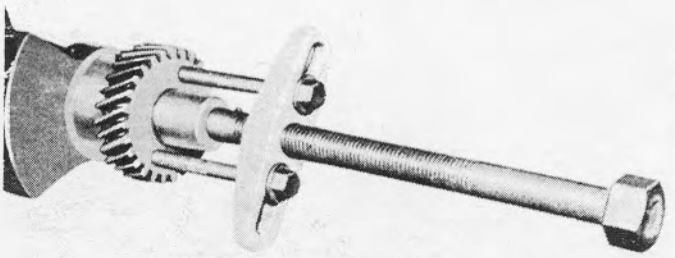
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Figure 12. Removing Crankshaft Gear

6. Install a new camshaft rear plug flush to 1/32" (.8mm) deep and parallel with rear surface of cylinder block.

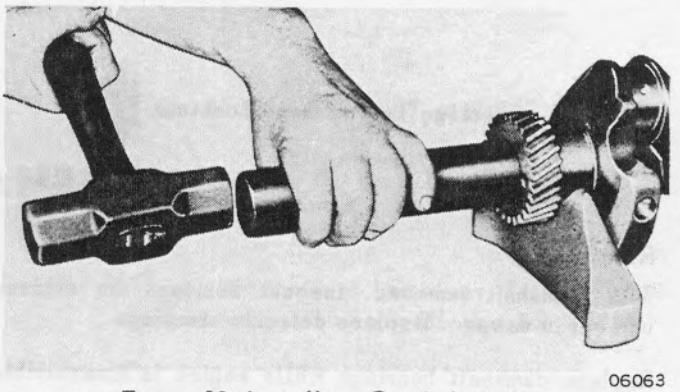
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Figure 13. Installing Crankshaft Gear

CYLINDER BLOCK

CLEANING and INSPECTION

1. Wash cylinder block thoroughly in cleaning solvent and clean all gasket surfaces.
2. Remove oil gallery plugs and clean all oil passages.

   NOTE: Remove plugs with a sharp punch or drill and pry out.

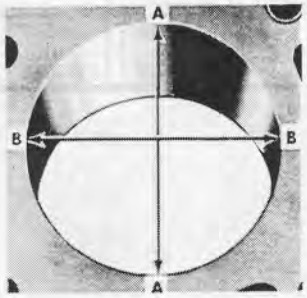

Figure 1. Cylinder Measurement

3. Clean and inspect water passages in cylinder block.
4. Inspect cylinder block for cracks in cylinder walls, water jacket valve lifter bores and main bearing webs.
5. Measure the cylinder walls for taper, out-of-round or excessive ridge at top of ring travel (Figure 1) with dial indicator. Set gauge so that thrust pin must be forced in about 1/4" (6.4mm) to enter gauge in cylinder bore. Center gauge in cylinder and turn dial to "0". Carefully work gauge up-and-down cylinder to determine taper and turn gauge to different points around cylinder wall to determine out-of-round condition. If cylinders exceed specifications, honing and boring are necessary. (Figure 2)

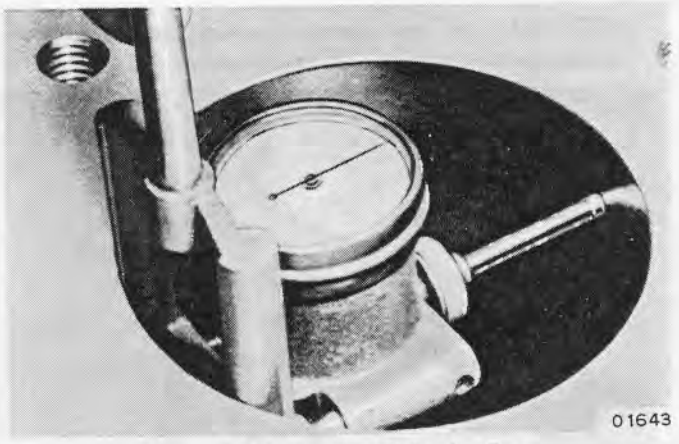

Figure 2. Measuring Cylinder Bore

REPAIRS

CYLINDER CONDITIONING

Condition of engine at time of repair is important. If inspection indicates that cylinder block is acceptable -- except for out-of-round or tapered cylinders, condition the block by honing or boring.

If cylinders have less than. 005" (.127mm) taper or wear, condition them with a hone and fit with high limit, standard size piston. A cylinder bore of less than .005" wear or taper may not clean up entirely when fitted to a high limit piston. To clean up bore entirely, in such a case, rebore for an oversize piston. If more than .005" taper or wear, bore and hone to smallest oversize that permits complete resurfacing of all cylinders.

When pistons are fitted (honing not necessary), clean (scrub) cylinder bores with detergent and hot water. After cleaning, swab cylinder bores several times with light engine oil and clean cloth, then wipe with clean, dry cloth.

CYLINDER BORING

1. Before using any type boring bar, file off top of cylinder block to remove dirt or burrs. This will guard against a tilted boring bar and assures that rebored cylinder wall is at right angles to crankshaft.
2. Measure piston, to be fitted, with a micrometer at center of piston skirt and at right angles to piston pin. Bore cylinder to same diameter as piston and hone cylinder to specifications (Section 8) and as outlined under "Cylinder Honing and Piston Fitting".
3. Carefully follow instructions furnished by manufacturer of equipment being used.

CYLINDER HONING

1. Follow hone manufacturer's recommendations for use of hone and cleaning and lubrication during honing.
2. Occasionally, during honing operation, thoroughly clean cylinder bore and check piston for correct fit in cylinder.
3. When finish honing a cylinder bore to fit a piston, move hone up-and-down to obtain very fine uniform surface finish marks in a cross-hatch pattern of approximately 45° to 65° included angle. Finish marks should be clean but not sharp and free from imbedded particles and torn or folded metal.

   CAUTION: Handle pistons with care and do not attempt to force them thru cylinder until cylinder has been honed to correct size, as this type piston can be distorted thru careless handling.

4. Permanently mark piston for cylinder to which it has been fitted and proceed to hone cylinders and fit remaining pistons.
5. Thoroughly clean cylinder bores with hot water and detergent. Scrub well with a stiff bristle brush and rinse thoroughly with hot water. Be absolutely certain that no abrasive material is allowed to remain in cylinder bores, or it will rapidly wear new rings and cylinder bores in addition to bearings lubricated by contaminated oil. Swab bores several times with light engine oil and a clean cloth, then wipe with a clean, dry cloth. DO NOT clean cylinder with kerosene or gasoline. Clean remainder of cylinder block to remove excess material spread during honing operation.

PISTON SELECTION

1. Check USED piston to cylinder bore clearance as follows:
   a. Measure "Cylinder Bore Diameter" with a telescope gauge (2-1/2" [63.5mm] from top of cylinder bore).

b. Measure "Piston Diameter" (at skirt across center line of piston pin).
c. Subtract piston diameter from cylinder bore diameter to determine "Piston to Bore Clearance".
d. Determine if piston to bore clearance is in acceptable range.

2. If used piston is not acceptable, check "Average Pistons Available" chart, following, and determine if a new piston can be selected to fit cylinder bore within acceptable range.
3. If cylinder bore must be reconditioned, measure new piston diameter (across centerline of piston pin), then hone cylinder bore to correct clearance (preferable range).
4. Mark piston to identify cylinder for which it was fitted.

OVERSIZE PISTONS AVAILABLE

ENGINE DISPLACEMENT	PISTON SIZE			
	.001"	.005"	.020"	.030"
153, 230 and 250	3.8760" to 3.8770"		3.8937 to 3.8957"	3.9037" to 3.9059"
181	3.9963" to 3.9973"	4.001" to 4.002"	4.0138" to 4.0158"	
292	3.8740" to 3.8750"		3.8938" to 3.8958"	3.9038" to 3.9058"

Metric Conversion: 1" = 25.4mm

DISTRIBUTOR LOWER BUSHING INSPECTION and REPLACEMENT

Distributor lower bearing is a bronze bushing pressed into lower side of engine block. Its upper inside diameter pilots distributor shaft, and outside diameter (extending below block) pilots oil pump.

Some engines have a thrust washer at upper end of bushing bore. Thrust washer, where used, may be replaced at same time bushing is replaced.

Lower bushing ordinarily will require only a clearance or wear check during engine overhaul. When distributor shaft-to-bushing clearance exceeds .0035", replace bushing as follows with oil pump and distributor removed:

NOTE: Later distributors use a bushing in distributor housing. Measuring clearance between cylinder block bushing and distributor shaft is not needed, since shaft is undercut.

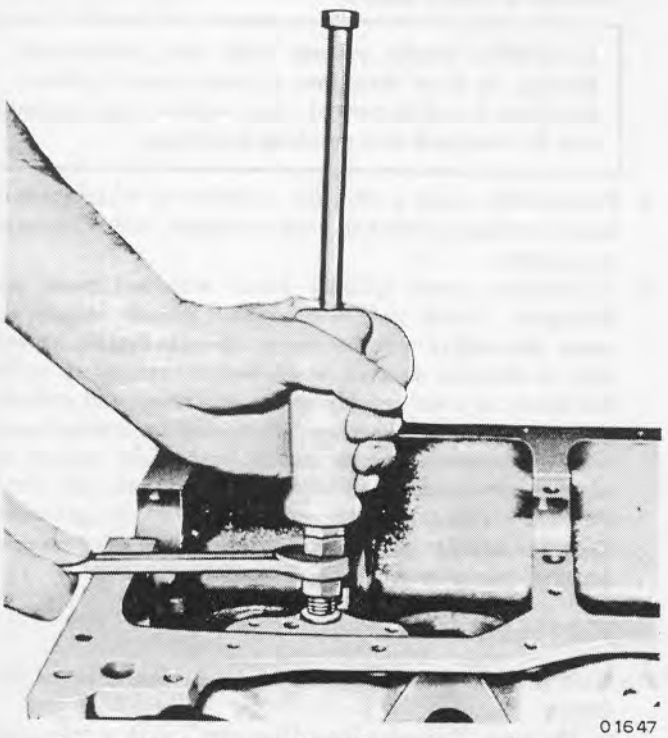

Figure 3. Removing Distributor Lower Bearing

1. Install Tool J-9534 into bushing and remove bushing with a slide hammer. (Figure 3)
2. Clean bushing bore in block and check for burrs or damage.
3. Use Tool J-9535 with driver-bolt in driver handle to install driver into new bushing from large inside diameter.
4. Position bushing and driver to block and drive bushing in position (Figure 4), which is determined by tool bottoming against block.
5. Remove tool from bushing. It is possible that bushing with minimum inside diameter will collapse enough during installation to slightly seize installer arbor. If this happens, remove installer tool with slide hammer in driver bolt hole of driver handle.

NOTE: This will not damage bushing, and tool is designed for this purpose, should it occur.

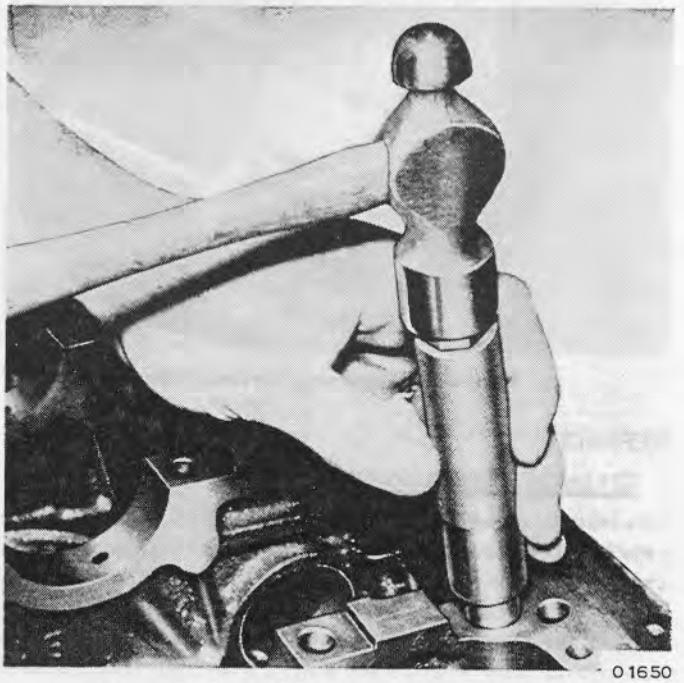

Figure 4. Install Distributor Lower Bearing

OIL NOZZLE REPLACEMENT

1. Remove nozzle with pliers. (Figure 5)
2. Drive new nozzle in place (oil hole in vertical position) with a suitable light plastic or rubber hammer.

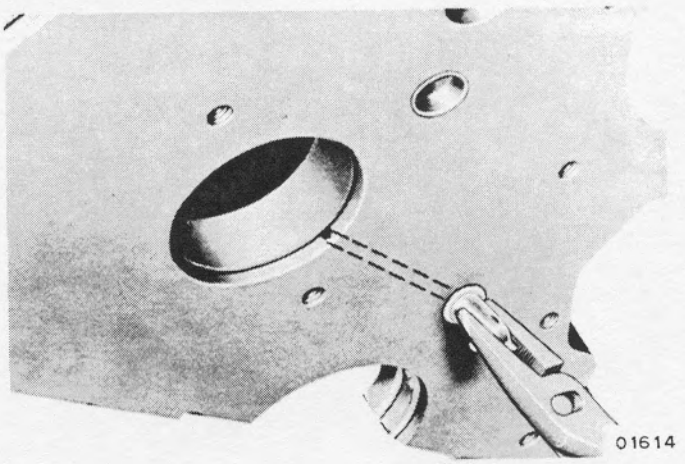

Figure 5. Oil Nozzle Replacement

OIL FILTER BYPASS VALVE and REPLACEMENT

With oil filter removed, check spring and fibre valve for operation. Inspect for a cracked or broken valve. If replacement is necessary, pry valve out with screwdriver. Install and seat a new valve by tapping in place with a 9/16 thin-wall deep socket. (Figure 6)

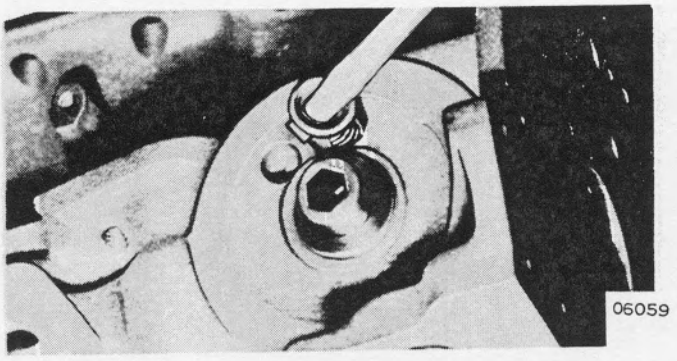

Figure 6. Oil Filter By-Pass Valve

SECTION 5 - ENGINE

MERCRUISER

PART B - ENGINE MECHANICAL, IN-LINE 60-80-90

MERCURY MARINE

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REMOVING INNER TRANSOM PLATE

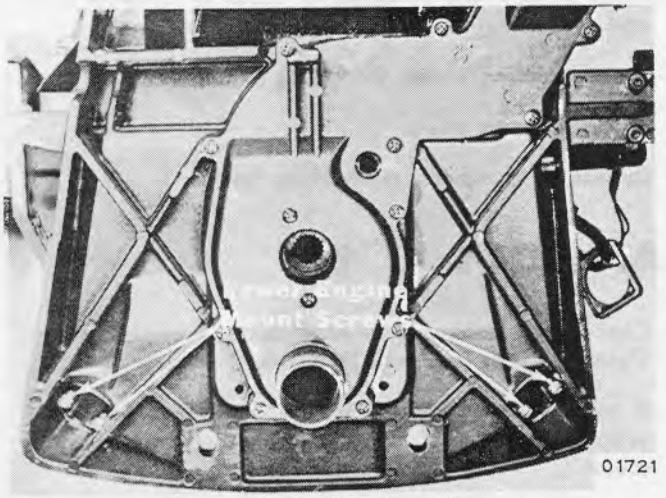

Figure 1. Engine Mount Screws

1. Remove engine from boat.
2. Remove inter-lock bolt and nut (located at base of inner transom plate) and disconnect wires and harness leads (attached to transom plate).
3. Remove water inlet hose from rear of engine block.
4. Loosen clamp which secures rubber exhaust bellows to exhaust manifold.
5. Remove screws which secure lower engine mounts to inner transom plate. (Figure 1)
6. Remove large nut on Ride-Guide steering tube and remove tube from tube support.
7. Pull out and down on transom plate to remove from engine.
8. Remove large washers (located on each side of Ride-Guide tube support).
9. Remove screws and nuts, which secure upper engine mount to cylinder head, and remove engine mount bracket.

INTAKE MANIFOLD - "60" and "90"

REMOVAL

1. Remove choke heat tube or rod and fuel inlet line.
2. Remove throttle cable and inlet fuel line clamp.
3. Remove crankcase ventilation hose from valve cover and cooling line from bottom of manifold.
4. Remove manifold attaching nuts and lift off manifold assembly.
5. If replacing manifold, transfer carburetor and throttle linkage to new manifold, using new gaskets.

CLEANING and INSPECTION

1. Clean gasket material from all surfaces and wash parts in solvent.
2. Inspect all parts carefully. Machined surfaces must be clean and free of all marks or deep scratches, or water leaks may result.
3. Check water passages for sand, silt or foreign material. Passages must be clean for efficient cooling.
4. If more thorough inspection is desired, remove pipe plugs from exhaust manifold elbow and exhaust pipe elbow.

INSTALLATION

1. Clean gasket surfaces.

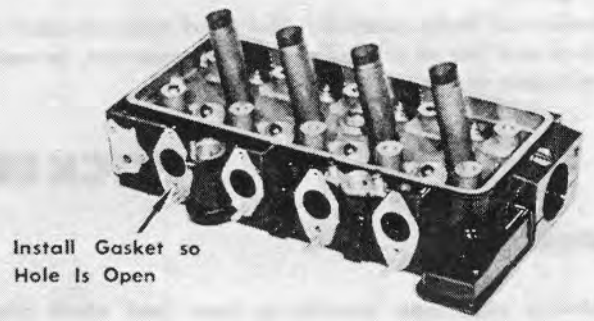

Figure 2. Intake Manifold Gasket Hole Location - "90"

2. Position gaskets and manifold on cylinder head and secure with attaching nuts. (Be sure that intake manifold gaskets are positioned so that only hole shown in Figure 2 is open for cooling water on "90".)
3. Install crankcase ventilation hose in valve cover and cooling line to inlet in bottom manifold.
4. Install throttle cable and inlet fuel line clamp.
5. Install choke heat tube or rod and carburetor fuel inlet.

EXHAUST MANIFOLD - "60" and "90"

REMOVAL

1. Remove attaching bolts which secure electrical panel to manifold.
2. Remove cooling hoses and choke assembly ("60" only).
3. Remove exhaust outlet hose.
4. Remove attaching bolts and stud nuts, then manifold.

CLEANING and INSPECTION

1. Clean gasket material from all surfaces and wash parts in solvent.
2. Inspect all parts carefully. Machined surfaces must be clean and free of all marks or deep scratches, or water leaks may result.
3. Check water passages for sand, silt or foreign material.

Passages must be clean for efficient cooling.
4. If more thorough inspection is desired, remove pipe plugs from exhaust manifold elbow and exhaust pipe elbow.

INSTALLATION

1. If replacing manifold body, transfer all components to new body.
2. Clean gasket surfaces.
3. Slide gasket and manifold on studs of cylinder head and secure with attaching bolts and nuts.
4. Install cooling hoses and wiring harness clamp.
5. Install exhaust hose.
6. Install electrical panel attaching bolts.

INTAKE/EXHAUST MANIFOLD - "80"

REMOVAL

1. Remove manifold cooling hoses.
2. Remove complete wiring harness and electrical component bracket from manifold.
3. Remove manifold attaching nuts. Remove manifold and carburetor as an assembly.
4. If replacing manifold body, transfer all components to new body.

CLEANING and INSPECTION

1. Clean gasket material from all surfaces and wash parts in solvent.
2. Inspect all parts carefully. Machined surfaces must be clean and free of all marks or deep scratches, or water leaks may result.
3. Check water passages for sand, silt or foreign material. Passages must be clean for efficient cooling.
4. If more thorough inspection is desired, remove pipe plugs from exhaust manifold elbow and exhaust pipe elbow.

INSTALLATION

1. Clean all gasket surfaces.
2. Position new gasket and manifold on head and secure with attaching nuts.
3. Install complete wiring harness and electrical component bracket.
4. Install manifold cooling hoses.

ROCKER ARM COVER

REMOVAL

1. Remove crankcase ventilation hose (and spark plug leads on "90" only).
2. Remove valve cover retaining nuts and lift off valve cover.

INSTALLATION

1. Clean gasket surfaces.
2. Position valve cover and gaskets properly on cylinder head.
3. Secure valve cover with retaining nuts.
4. Install spark plugs leads ("90" only) and crankcase ventilation hose.

VALVE ADJUSTMENT

ENGINE RUNNING

NOTE: Complete the following procedure (performed with engine at normal operating temperature) only if readjustment is required.

1. Remove valve cover and install valve cover with cut-out top to prevent oil from running out.
2. With engine running at idle, loosen rocker arm nut and turn adjustment screw until feeler gauge can be inserted between rocker arm and valve stem. (Figure 3) Adjust "80" and "90" valves with Tool C-91-47160.
3. Insert feeler gauge of correct thickness.
4. Turn rocker arm nut down until light drag is felt on feeler gauge for correct valve lash.

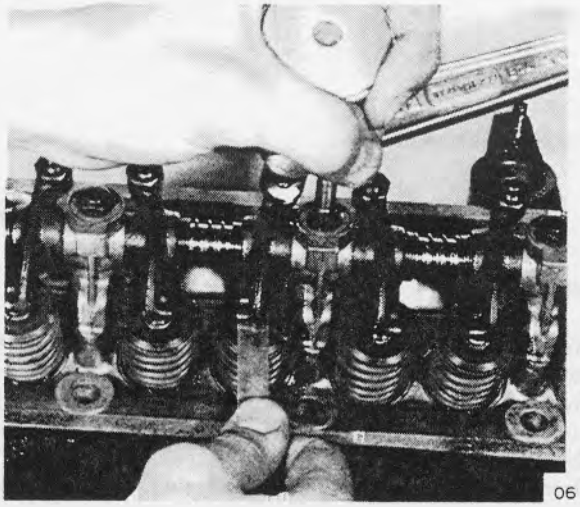
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Figure 3. Valve Adjustment

NOTE: Be sure to distinguish between intake valves and exhaust valves, as each requires a different clearance. (Figure 3)

5. Repeat Steps 2, 3 and 4 to adjust remaining valves.
6. Install valve cover and new gasket.

ENGINE STOPPED

1. Remove valve cover.
2. Crank engine until proper valve is open and adjust 2 valves listed in adjustment sequence, following:

VALVE ADJUSTMENT SEQUENCE

VALVE OPEN	ADJUST VALVES	
EXHAUST	INTAKE	EXHAUST
1	3	4
3	4	2
4	2	1
2	1	3

3. Adjust valves by inserting a feeler gauge of specified thickness between rocker arm and valve stem. (Figure 4)

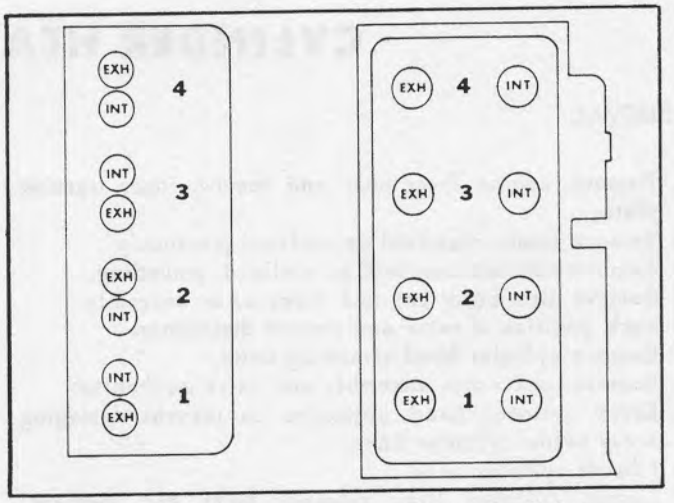

Figure 4. Valve Location - "60" and "80"

Figure 5. Valve Location - "90"

NOTE: Valve specifications differ for intake and exhaust valves. See Figure 5 or 6 for valve identification.

4. Install valve cover.
5. Run engine until warm and recheck valve clearances. If incorrect, adjust as outlined under, "Valve Adjustment, Engine Running", preceding.

ROCKER ARM ASSEMBLIES

DISASSEMBLY

1. Remove pin or keeper from rocker arm mount.
2. Slide shaft out of mount.
3. Mark position of rocker arms for reinstallation in same position.

CLEANING and INSPECTION

1. Check for excessive wear between rocker arm shafts and rocker arms (minimum .006" [.016mm], maximum .002" [.052mm]).
2. Clean all oil passages in rocker arm shafts and mounts.

REASSEMBLY

1. Position rocker arms in original location with shaft springs.
2. Slide rocker arm shaft in thru rocker arm mount and rocker arms.
3. Locate pin or keeper thru rocker arm mount and rocker arm shaft.

VALVE MECHANISM

REMOVAL

1. Remove valve cover.
2. Remove bolts which secure rocker arm shafts.
3. Remove push rods and keep in order for reinstallation in same position.
4. Lift off rocker arm and shaft assemblies.

CLEANING and INSPECTION

1. Check all components removed for nicks, grooves, roughness or excessive wear.
2. Visually check push rods for straightness (while they are installed in engine) by rotating rods with valve closed. Rods also may be checked with a dial indicator.

INSTALLATION

1. Install rocker arms and torque bolts to specifications (in sequence, "90" only).
2. Loosen rocker arms and install push rods in original positions.
3. Adjust valve clearance with engine NOT running, as outlined.
4. Install valve cover with new gasket.

CYLINDER HEAD - "60" MODEL

REMOVAL

1. Remove engine from boat and remove inner transom plate.
2. Remove intake manifold as outlined previously.
3. Remove exhaust manifold as outlined, preceding.
4. Remove distributor cap and wires as an assembly.
5. Mark position of rotor and remove distributor.
6. Remove cylinder head attaching bolts.
7. Remove rocker arm assembly and valve mechanism.
8. Drive cylinder head sideways to prevent damaging seals below cylinder liner.
9. Lift off cylinder head.
10. Install cylinder liner retainer bolts and washers. (Figure 1)
11. If replacing cylinder head, transfer all components to new head.

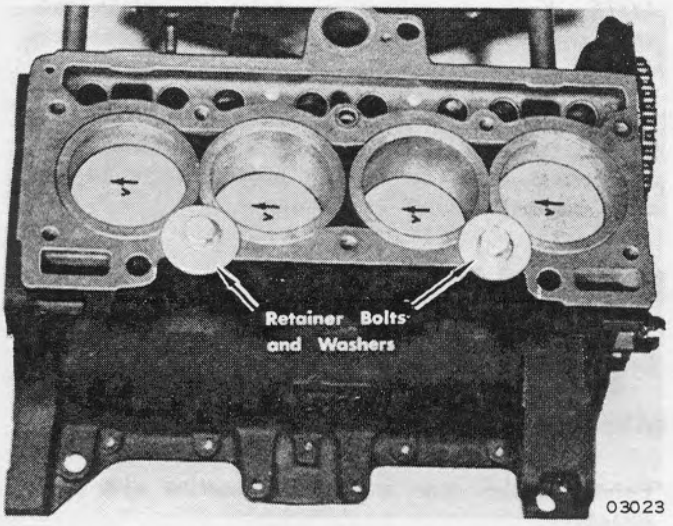

Figure 1. Cylinder Liner Retaining Bolts

INSTALLATION

1. Remove cylinder liner retaining washers and bolts. Place cylinder head gasket in position (beaded edge toward cylinder block).

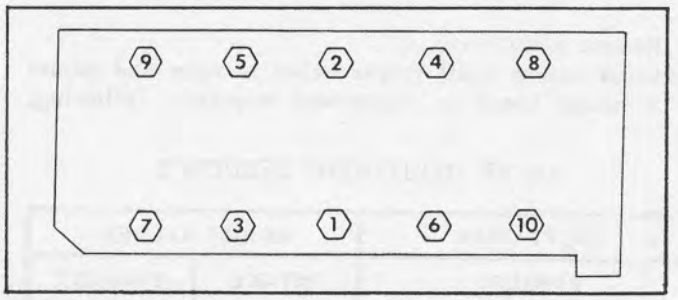

Figure 2. Cylinder Head Torquing Sequence

2. Place cylinder head in position, carefully aligning with locating dowel.
3. Install cylinder head fasteners and torque to specifications in sequence shown in Figure 2.

CAUTION: Exercise extreme care while tightening head bolts to protect threads in aluminum block.

4. Install rocker arm and shaft assembly and position rocker arms over push rods.
5. Install fasteners and washers and tighten securely.
6. Adjust rocker arm clearance as outlined previously.
7. Install rocker arm cover.

IMPORTANT: Cylinder head MUST be retorqued after running.

CYLINDER HEAD - "80" and "90"

REMOVAL

1. Remove engine from boat and remove inner transom plate.
2. Remove intake manifold as outlined.

NOTE: Intake and exhaust manifolds are combined on "80".

3. Remove exhaust manifold as outlined, preceding.
4. Remove distributor cap and wires as an assembly.
5. Mark position of rotor and remove distributor.
6. Remove cylinder head attaching bolts.
7. Remove rocker arm assembly and valve mechanism.
8. Drive cylinder head sideways to prevent damaging seals below cylinder liner.
9. Lift off cylinder head.
10. Install cylinder liner retainer bolts and washers. (Figure 3)
11. If replacing cylinder head, transfer all components to new head.

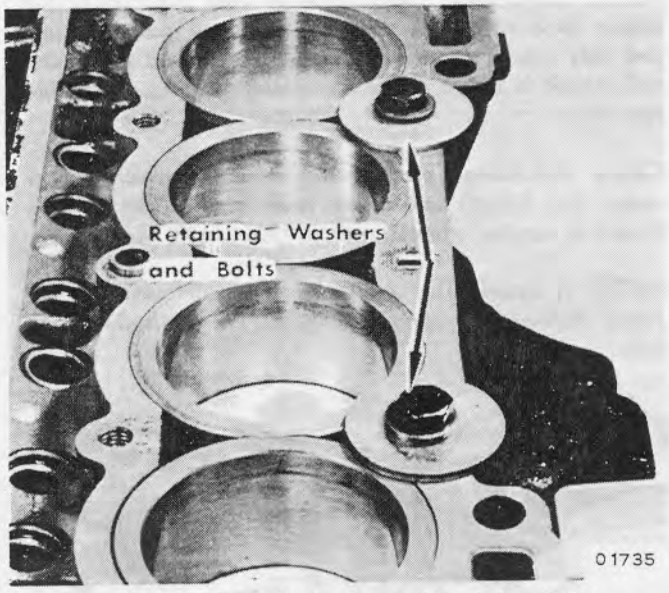

Figure 3. Cylinder Liner Retaining Bolts

INSTALLATION

1. Remove cylinder liner retaining washers and bolts. Place cylinder head gasket in position (beaded edge toward cylinder block).
2. Install proper cylinder head positioning tool (listed below) in location shown in Figure 4.

HEAD INSTALLATION TOOLS

"80"	C-91-46956
"90"	C-91-58595

3. Fit rubber gasket around camshaft recess without overlapping head gasket at ends.

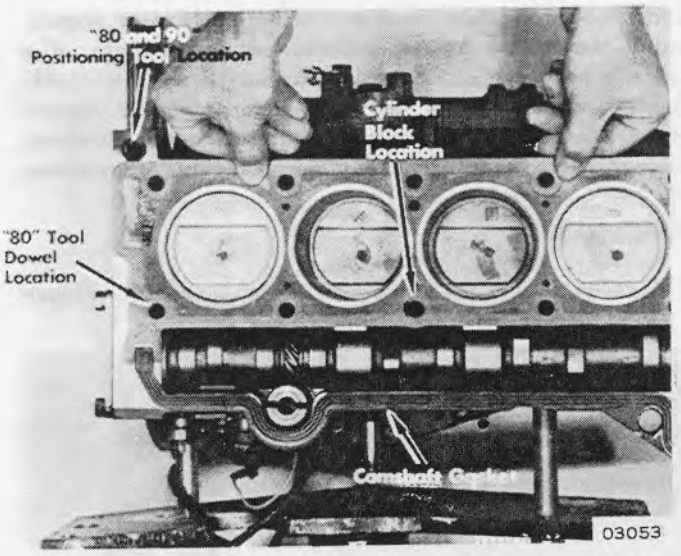

Figure 4. Head Gasket Positioning

IMPORTANT: Correct cylinder head alignment is necessary for distributor pinion and valve train alignment.

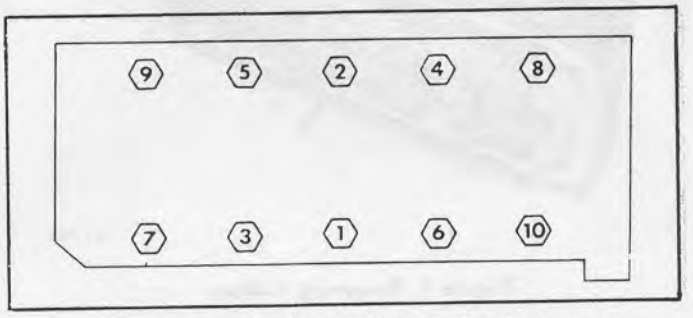

Figure 5. Cylinder Head Torquing Sequence

4. Place cylinder head in position, aligning with locating tool.
5. Install cylinder head screws and washers and torque to specifications in sequence shown in Figure 5. Model "90" head screws also secure rocker arm assembly.

CAUTION: Exercise extreme care while tightening head bolts to protect threads in aluminum block.

6. Install rocker arm push rods.
7. Install rocker arm and shaft assembly and position rocker arms over push rods.
8. Install fasteners and washers and tighten securely.
9. Adjust rocker arm clearance as outlined.
10. Install rocker arm cover.

IMPORTANT: Cylinder head MUST be retorqued after running.

CYLINDER HEAD and VALVE RECONDITIONING

"60 - 80 - 90"

Condition of cylinder head and valve mechanism significantly determines power, performance and economy of a valve-in-head engine. Exercise extreme care when conditioning cylinder head and valves to maintain correct valve stem to guide clearance, correctly ground valves, correct valve seat width and correct valve adjustment.

DISASSEMBLY

1. Remove rocker arms and shaft as an assembly. (Figure 1)

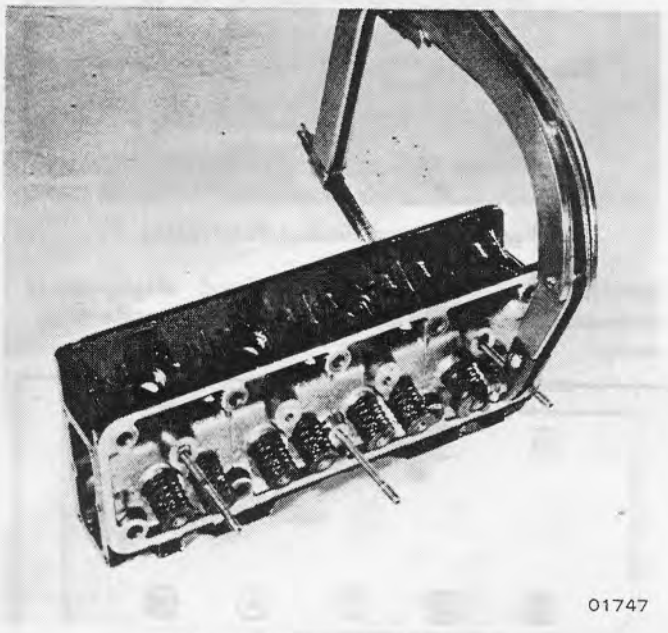

Figure 1. Removing Valves

2. Compress valve springs with valve spring compressor and remove valve keys.

   NOTE: Intake and exhaust valve keys are not identical and must not be mixed.

3. Release spring compressor and remove spring caps, valve springs and base washers. (Figure 2)
4. Remove valves from bottom of cylinder head and place valves in a rack in correct sequence for reassembly in original positions.
5. Remove valve tappets.

CLEANING

1. Clean all carbon from combustion chambers and valve ports.
2. Thoroughly clean valve guides.
3. Clean all carbon and sludge from push rods and rocker arms.
4. Clean valve stems and heads on a buffing wheel.
5. Clean carbon deposits from head gasket mating surfaces.
6. Wash all parts in cleaning solvent and dry them thoroughly.

INSPECTION

1. Inspect cylinder head for cracks in exhaust ports, combustion chambers or external cracks to water chamber.
2. Inspect valves for burned heads, cracked faces or damaged stems.
3. Check cylinder head mating surface for possible warping or distortion. (Figure 2) Maximum permissable distortion is .002" (.051mm).

   NOTE: Reface head if bowed beyond .002".

4. If valve guide wear is excessive, replace valve guide.

   NOTE: Excessive valve stem to bore clearance will cause lack of power, rough idling and noisy valves and may cause valve breakage. Insufficient clearance will result in noisy and sticky valves and rough engine operation.

5. Check individual intake and exhaust valve springs under free length and under load length. Use lengths listed in engine specifications (Section 8) for checks.

   NOTE: If spark plug hole thread is stripped, install 14mm heli-coil insert (C-92-45831) in cylinder head hole.

Figure 2. Cylinder Head Flat Surface

RECONDITIONING

REPLACING VALVE GUIDE

1. Position cylinder head on wedge and press valve guide out with mandrel.
2. Check outer diameter of guide and determine if it is standard or oversize. Use engine specifications for sizes.
3. Replacement guide must be one size larger than valve guide that has been removed. Ream cylinder head guide hole with a reamer corresponding to new valve guide outer diameter. (Figure 3)

VALVE GUIDE TOOLS		
TOOL	"60"	"80-90"
Wedge	C-91-37023	C-91-46803
Mandrel	C-91-39284A1	C-91-46773
Head Reamer	C-91-37002A1	C-91-46777
Guide Reamer	C-91-37002A1	C-91-46778

4. Coat press-fit area of guide with Super-Duty Gear Lubricant (C-92-52650). Install new guide with mandrel. Tool should bottom on head.
5. Ream new guide with reamer to bring internal diameter to correct size. (Figure 4)

NOTE: After changing a guide, it is absolutely necessary to regrind the corresponding valve seat.

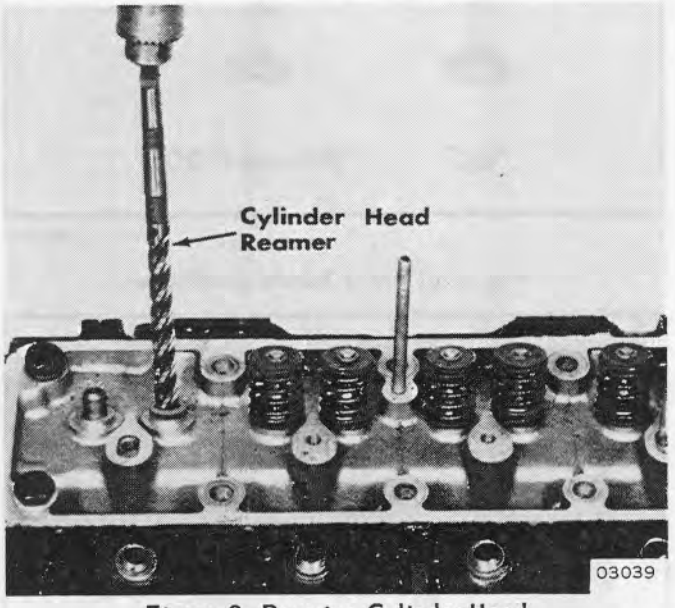

Figure 3. Reaming Cylinder Head

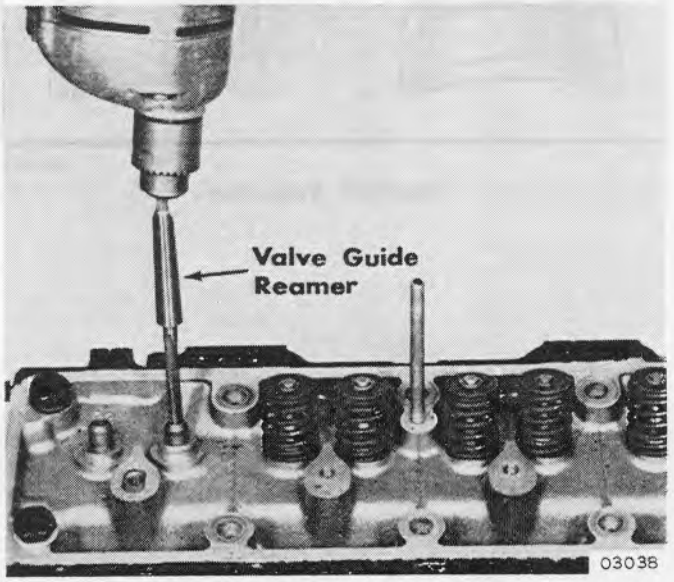

Figure 4. Reaming Valve Guide

VALVE SEAT (CYLINDER HEAD)

Seating of valves must be perfect for engine to deliver power and performance built into it.

Another important factor is cooling of valve heads. Good contact between each valve and its seat in head is imperative to ensure that heat in valve head is properly carried away.

Carefully follow recommendations of manufacturer of equipment (for reseating valve seats) to attain proper results.

Regardless of what type of equipment is used, however, it is essential that valve guides be free from carbon or dirt to assure proper centering of pilot in guide.

1. Install expanding pilot in valve guide bore and expand pilot by tightening nut on top of pilot.
2. Place roughing stone or forming stone over pilot and just clean up valve seat. Use a 45° stone for inlet and exhaust valve seats.
3. Remove roughing stone or forming stone from pilot, install finishing stone on pilot and cut just enough metal from seat to provide a smooth finish.
4. Narrow down valve seats to proper width, according to specifications, by grinding port side with a 30° stone to lower seat and a 60° stone to raise seat.
5. Remove expanding pilot and clean cylinder head carefully to remove all chips and grinding from above operations.

NOTE: Valve seats should be concentric to within .002" (.051mm) total indicator reading. (Figure 5)

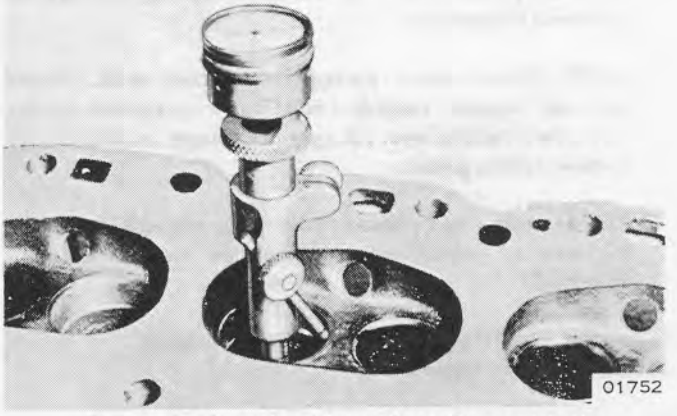

Figure 5. Checking Valve Seat Concentricity

VALVES

Reface pitted valves to proper angle, insuring correct relation between head and stem on a valve refacing machine. Valve stems which show excessive wear, or valves that are warped excessively, should be replaced. When a valve head, which is warped excessively, is refaced, a knife edge will be ground on part or all of valve head due to amount of metal that must be removed to completely reface. Knife edges lead to breakage, burning or preignition when heat localizes on this knife edge. If edge

of valve head is less than 1/32" (.795mm) thick after grinding, replace valve.

1. If necessary, dress valve refacing machine grinding wheel to make sure it is smooth and true. Set chuck at 45° mark for grinding valves.
2. Clamp valve stem in chuck of machine.
3. Start grinder and move valve head out in line with grinder wheel by moving lever to left.
4. Turn feed screw until valve head just contacts wheel. Move valve back and forth across wheel and regulate feed screw to provide light valve contact.
5. Continue grinding until valve face is true and smooth all around valve. If this makes valve head thin, valve must be replaced, as valve will overheat and burn.
6. Remove valve from chuck and place stem in "V" block. Feed valve squarely against grinding wheel to grind any pit from rocker arm end of stem.

   NOTE: Only extreme end of valve stem is hardened to resist wear. Do not grind end of stem excessively.

7. After cleaning valve face and cylinder head valve seat of grinding particles, make pencil marks about 1/4" apart across valve face, place valve in cylinder head and give valve 1/2 turn in each direction while exerting firm pressure on face of valve.
8. Remove valve and check face carefully. If all pencil marks have not been removed at point of contact with valve seat, it will be necessary to repeat refacing operation and again recheck for proper seating.
9. Grind and check remaining valves in same manner.

REASSEMBLY

1. Starting with No. 1 cylinder, place exhaust valve in port and place base washer, valve spring and cap in position. (Figure 6)

   NOTE: Place valve springs in position with closed coil end toward cylinder head, then compress spring and install valve keys. Be sure that keys seat properly in valve stem groove.

   NOTE: Intake and exhaust valve keys are not identical. Be sure to install correct keys on correct valves. (Figure 7)

2. Install remaining valves in the same manner.
3. Install valve tappets.

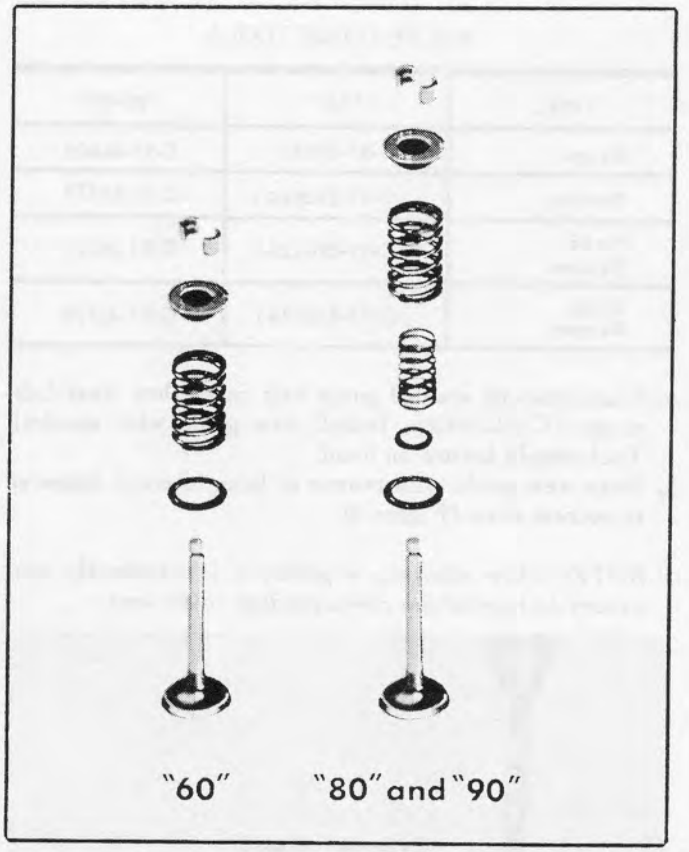

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Figure 6. Valve Spring Installation

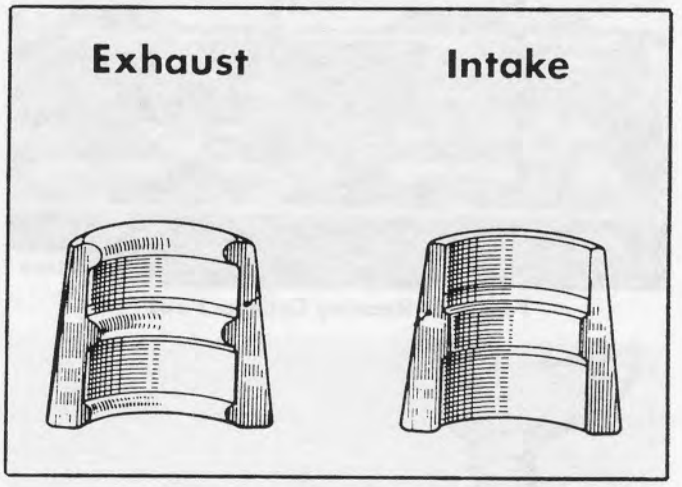

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Figure 7. Valve Keys

OIL PAN

REMOVAL

1. Remove attaching screws.
2. Dislodge pan from cylinder block and remove.

INSTALLATION

1. Cut off 2 main bearing side seals flush with cylinder block. Refer to Figure 5, preceding (except "60").
2. Install oil pan gasket with Perfect Seal No. 4 (C-92-34227-1).
3. Install oil pan and screws. Tighten screws evenly to avoid distorting oil pan and/or gasket.
4. Install camshaft cover plate and gasket, if so equipped.

OIL PUMP - MERCRUISER "60"

1. Oil pump (Figure 1) consists of 2 gears and a pressure relief valve enclosed in a 2-piece housing and driven from distributor drive shaft which, in turn, is driven by a helix gear on camshaft.
2. Oil pump is flange-mounted to cylinder block with 3 bolts.
3. Oil pressure passes thru opening in mounting flange to cylinder block, then into full flow oil filter.
4. Pump cover is equipped with pressure regulator valve which regulates oil pressure at approx. 50 PSI (3.515 kg/cm^2) at 4000 RPM.
5. Pump intake is fixed screen type. A mesh screen filters out any small particles of dirt and sludge.

REMOVAL

1. Remove oil pan.
2. Remove 3 attaching bolts from cylinder block and remove oil pump.

DISASSEMBLY - "60"

1. Remove pump cover attaching screws. Be careful when separating cover from body, as pressure regulator spring, seat and ball are under compression. (Figure 1)
2. Remove drive pinion and shaft and idle gear. (Figure 1)
3. Wash all parts in cleaning solvent and dry with compressed air.

INSPECTION (Figure 1)

1. Inspect pump body for cracks or excessive wear.
2. Inspect oil pump gears for excessive wear or damage.

NOTE: If clearance between the pinion and pump body is over .008" (0.2mm), change drive pinion, shaft and idle gear.

3. Check shaft for condition of spline and for loose fit in housing.
4. Check cover parting face and resurface the face if worn or scored.
5. In case of insufficient oil pressure, check condition of ball and seat and replace pressure regulator spring.

REASSEMBLY (Figure 1)

1. Install drive pinion and shaft and idle gear in pump body.
2. Install regulator spring, ball and seat in pump body.
3. Compress regulator spring and install cover. Tighten screws evenly to prevent distortion.
4. Check that shaft turns freely after reassembly.

INSTALLATION

1. Install oil pump with new gasket and secure with 3 attaching bolts.
2. Install oil pan.

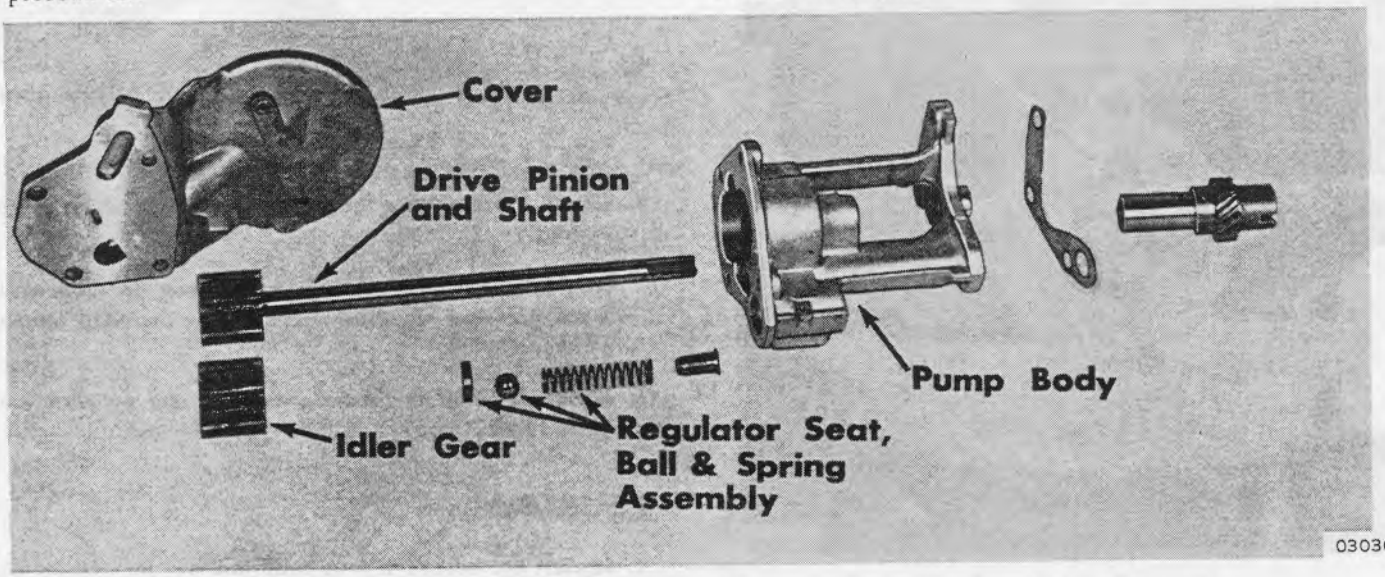

Figure 1. Oil Pump Components

OIL PUMP - "80" and "90"

1. Oil pump (Figure 2) consists of 2 rotors and a pressure relief valve enclosed in a one-piece housing and driven from distributor drive shaft which, in turn, is driven by a helix gear on camshaft.
2. Pump body is part of the cylinder block.
3. Oil pressure passes thru opening to cylinder block, then into full flow oil filter.

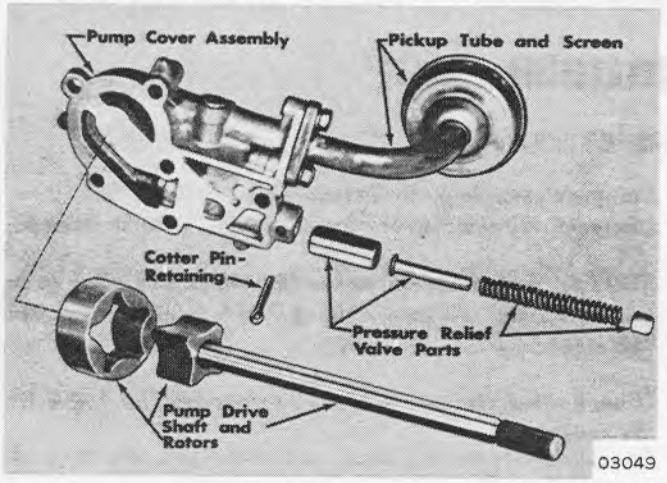

Figure 2. Oil Pump Components

4. Pump cover is equipped with pressure regulator valve which regulates oil pressure at approx. 50 PSI (3.52 kg/cm^2) at 4000 RPM.
5. Pump intake is fixed-screen type. A mesh screen filters out any small particles of dirt and sludge.

REMOVAL

1. Remove oil pan.
2. Remove oil pump cover attaching screws and remove cover assembly.
3. Pull oil pump rotors out of cylinder block. (Figure 3)

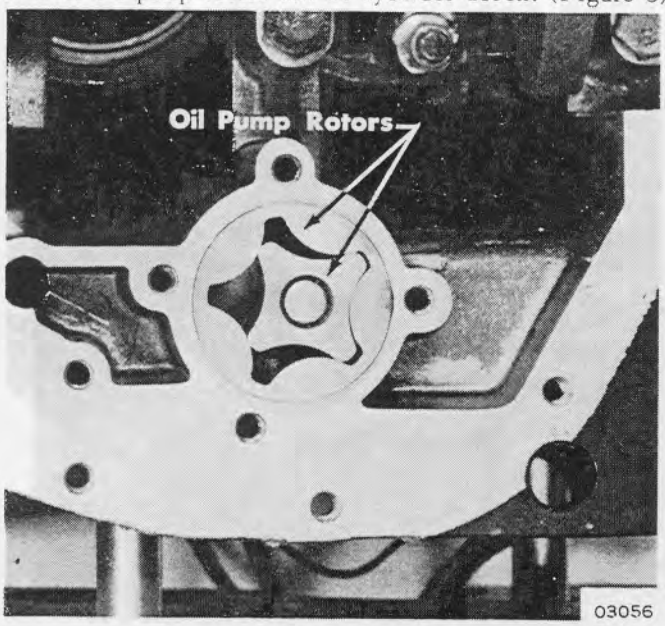

Figure 3. Oil Pump Rotors

DISASSEMBLY

1. Remove pump retaining cotter pin. Be careful when removing pin from cover, as the pressure regulator spring valve, etc, are under compression. (Figure 2)
2. Bend tab washers on pickup tube attaching screws and remove screws.

CLEANING and INSPECTION

1. Inspect pump body for cracks or excessive wear.
2. Inspect oil pump gears for excessive wear or damage by placing outer rotor into cylinder block and checking clearances.

Clearance "A" (Figure 4)
Min. .004" (.10mm)
Max. .010" (.25mm)
Clearance "B" (Figure 5)
Min. .003" (.07mm)
Max. .007" (.18mm)

If clearances are excessive, replace both rotors.

3. Check shaft for condition of spline and for looseness in housing.

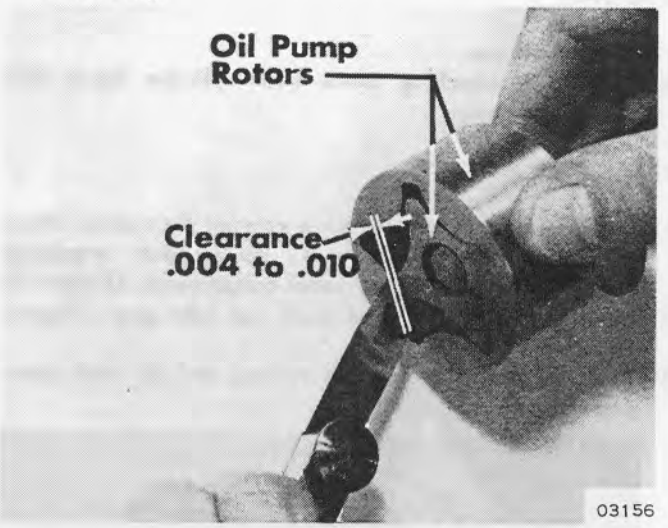

Figure 4. Clearance "A"

4. Check cover parting face and resurface face if worn or scored.

NOTE: Insufficient oil pressure may be caused by weak pressure regulator spring or by improper seating of check valve.

5. Wash all parts in cleaning solvent and dry with compressed air.

REASSEMBLY

1. Install oil screen pickup tube and secure screws with tab washers, if previously removed.

2. Install regulator spring, valve, etc, in pump cover.

NOTE: There have been instances where oil pump in engine has become loose, thus causing a loss in oil pressure on MerCruiser "80" Engines between Engine Serial No. 2049045 and 2050044.

3. Position cover on cylinder block and secure with attaching bolts.

INSTALLATION

1. Install oil pump rotors in cylinder block.
2. Place oil pump cover in position on cylinder block and secure with attaching screws.
3. Install oil pan.

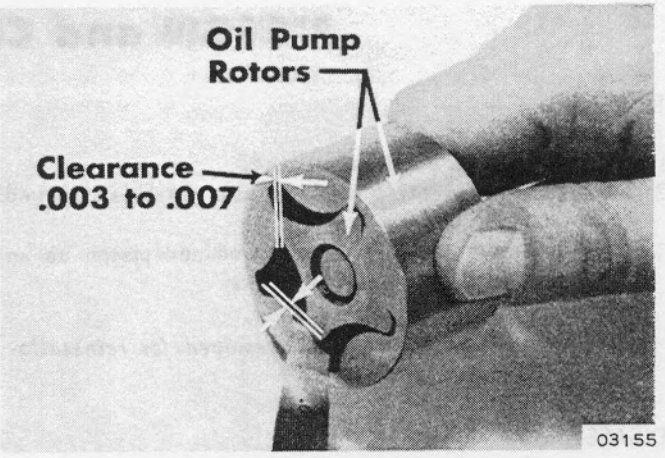

Figure 5. Clearance "B"

PISTON and CONNECTING ROD

REMOVAL

1. Remove cylinder head as outlined.
2. Disconnect connecting rod cap tube which is removed from crankshaft.
3. Push cylinder liner, connecting rod and piston as an assembly out top of cylinder block.

NOTE: Mark each component removed for reinstallation in same location.

DISASSEMBLY

1. Install pilot of piston pin with Removing and Installing Tool on piston pin.
2. Install piston and connecting rod assembly on support and place assembly in an arbor press. (Figure 1) Press pin out of connecting rod.

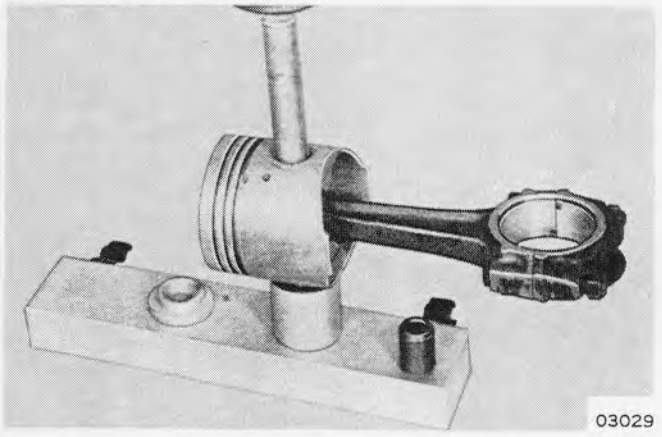

Figure 1. Removing Piston Pin

3. Remove assembly from press, remove piston pin from support and remove tool from piston and rod.

PISTON PIN TOOL	
"60"	C-91-37011
"80"	C-91-46771
"90"	C-91-46771

INSPECTION

1. Check condition of connecting rod, using dummy shaft and a connecting rod checking device.
2. Straighten connecting rod, if necessary.

REASSEMBLY (MerCruiser "60" Only)

1. Prior to installation of the MerCruiser "60" piston pin, the following operation in necessary.

   Piston is externally spot faced at one of its 2 reamed bores. On spot faced opening and on opposite side, cut a slight chamfer (.016" to .020" [.4mm to .5mm]) with a chamfering tool as follows:

   a. Engage tool-holder (3) between 2 piston openings, tool cutter toward hole to be chamfered. (Figure 2)
   b. Screw installing mandrel (1), fitted with dummy shaft (2), in tool holder. (Figure 2)
   c. Cut a regular chamfer, lightly turning and pressing knurled mandrel.
   d. Check that piston pin rotates correctly inside corresponding new piston.

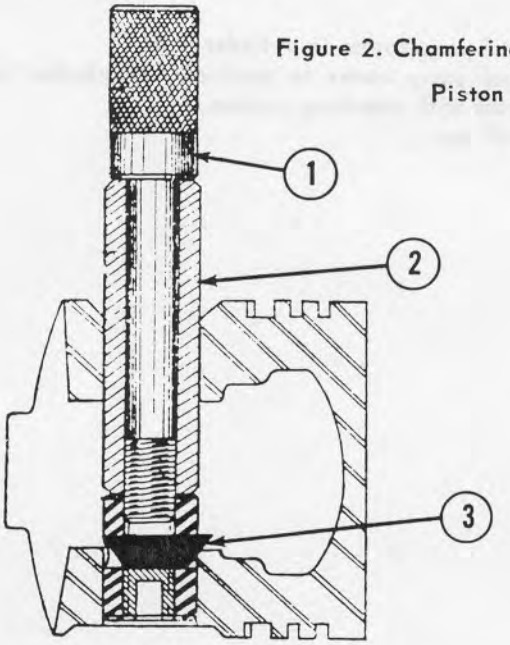

Figure 2. Chamfering Piston ("60")

2. Place new piston pin in installing mandrel (1 in Figure 3). Screw aligning bushing (2) onto installing mandrel. DO NOT TIGHTEN. Coat piston pin with engine oil.

Figure 3. Preparing Piston Pin

3. Dip connecting rod small end in a container of boiling water (100°C or 212°F).

   NOTE: A 250°C (482°F) electric oven is preferred to boiling water. (Figure 4)

4. Following operations should be carried out rapidly to reduce heat loss to a minimum (particularly when using boiling water):
   a. Manually fit guide-shaft-mandrel assembly in piston and connecting rod small end until piston pin contacts connecting rod.

   NOTE: Reference arrow on piston must face up and number on connecting rod large end must face to right side.

Figure 4. Heating Connecting Rod

b. Place piston and rod assembly on support block fitting guide, making sure that piston spotfacing is aligned with guide collar.
c. Using an arbor press, press mandrel until aligning bushing contacts bottom of fitting guide. (Figure 5)

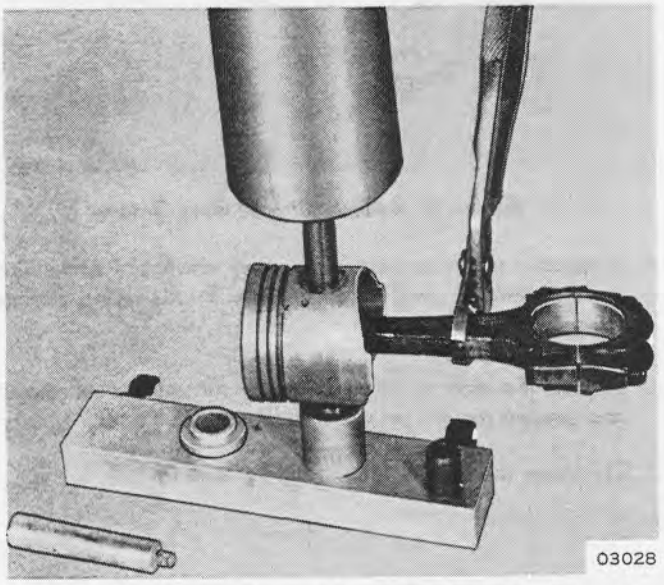

Figure 5. Assembling and Installing Piston, Pin and Connecting Rod

NOTE: Depth of guide bore is designed to obtain correct alignment of connecting rod in reference to piston pin.

INSTALLATION

1. Install piston and connecting rod assembly in cylinder liner with suitable ring compressor. Be sure that pistons and rings are oiled and ring gaps are spaced around piston at 120°. Install piston thru bottom of piston liner, as shown.
2. Install connecting rod-piston-liner assemblies, paying particular attention to reference marks and No. 1 at flywheel end. Arrows on piston tops should point toward flywheel end.
3. Install bottom seals on cylinder liners and place cylinder liners in cylinder block. (Figure 6)

NOTE: Be careful not to damage paper seals when installing. If installation difficulty is experienced, place seals under a wet cloth to make pliable.

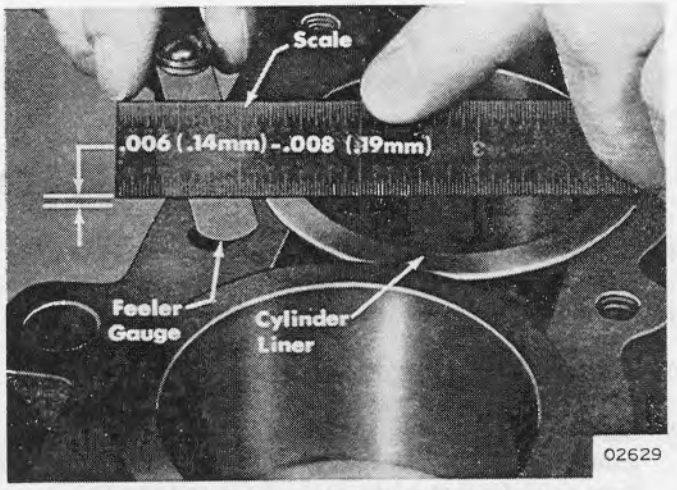

Figure 6. Checking Height of Cylinder Liner

4. Press down on liners by hand. Use a scale and feeler gauge. (Figure 6) Cylinder liner must protrude between specifications, obtained with cylinder liner base gaskets of various thicknesses (.003" [.07mm] and .004" .10mm). Take measurements at 2 points opposite one another on each side of liner. Difference should not be over .001" (.025mm). If over .001", turn liner 180° and recheck. (Metric conversion: 1" = 25.4mm)

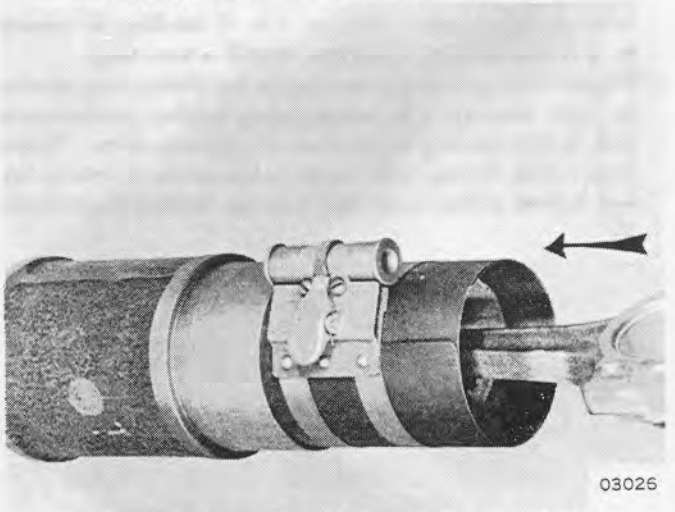

Figure 7. Installing Piston in Cylinder Liner

5. Install cylinder liner retaining washers and bolts.
6. When installing connecting rod caps and inserts on their respective connecting rods, check bearing clearances.

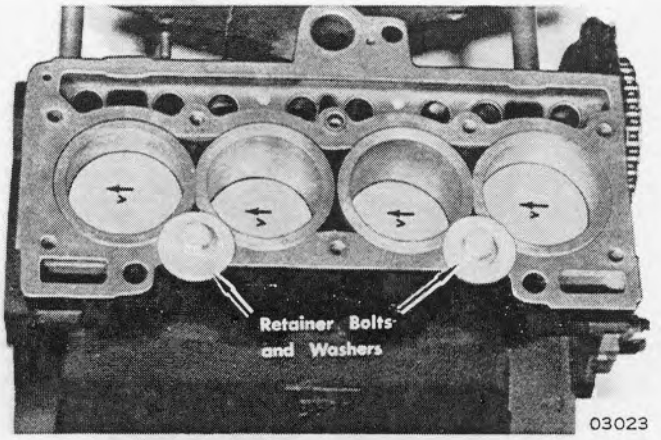

Figure 8. Installing Cylinder Liner Assemblies

PISTON RINGS

Piston rings are available in standard size only. Top compression ring is chrome plated; second compression ring is plain. Third ring is the oil control ring.

1. Remove piston rings by expanding them and sliding them off ends of pistons.
2. Carefully remove all particles of carbon from ring grooves in piston and inspect grooves carefully for burrs or nicks that might cause rings to hang up.
3. Slip outer surface of compression ring into piston ring groove and roll ring entirely around groove to make sure that ring is free and does not bind in groove at any point. (Figure 9) If binding occurs, cause should be determined and corrected by carefully dressing with a fine file. However, if binding is caused by a distorted ring, install a new ring.
4. Flex oil ring assembly in its groove to make sure ring is free and does not bind in groove at any point. If binding occurs, determine cause and correct by carefully dressing with a fine cut file. If binding is caused by a distorted ring, however, install a new ring.
5. Proper clearance of piston ring in its piston ring groove is very important in maintaining engine performance and in preventing excessive oil consumption. Therefore, when fitting new rings, clearances between top and bottom surfaces of ring grooves should be inspected.

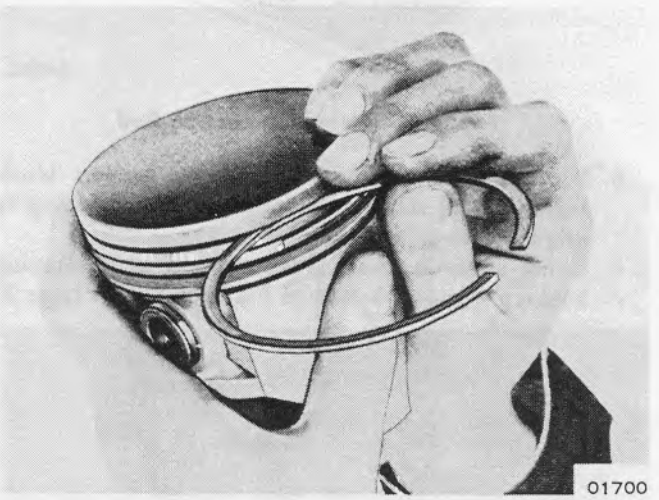

Figure 9. Rolling Ring in Ring Groove

6. Assemble rings to pistons as they are fitted and make a final test of ring fit in grooves by repeating fitting procedure given above.

   NOTE: Be sure to fit each ring to its individual piston and groove for proper groove clearance.

7. Oil rings and space gaps around piston at 120°.

CYLINDER LINERS

INSPECTION

1. Check cylinder walls for taper, out-of-round or excessive ridge at top of ring travel with a dial indicator. Set gauge so that thrust pin must be forced in about 1/4" (6.35mm) to enter gauge in cylinder bore. Center gauge in cylinder and turn dial to "0". Carefully work gauge up and down cylinder to determine taper and turn it to different points around cylinder wall to determine out-of-round condition. Replace cylinder if more than .002" (0.05mm) out-of-round.
2. If cylinder liner inspection indicates that cylinders are suitable for continued use, except for out-of-round or tapered condition, they can be conditioned by honing.

HONING

1. First use rough stones, then fine stones for final operation. Hone only enough to remove all cylinder wall glaze. Unless cylinder wall glaze is removed, new rings will not seat properly.
2. Place all cylinder liners in block and secure cylinder liner to be honed with 2 retaining washers (C-12-32-757)and suitable bolts. (Figure 10)
3. Place hone into cylinder bore and expand stones until hone can just be turned by hand. Connect a 1/2" electric drill to hone and drive hone at drill speed while moving hone up and down entire length of cylinder until hone begins to run free. During this operation, use a liberal amount of kerosene as a cutting fluid to keep stones clean. Move hone slowly up and down with rough stones but move hone up and down as rapidly as possible with fine stones in final operation. Final bore finish should show very fine surface scratches in a cross-hatch pattern.
4. Expand stones against cylinder bore and repeat honing operation until all cylinder wall glaze is removed. (Figure 10)
5. Hone remaining cylinders in same manner.
6. Thoroughly clean cylinder bores with hot water and soap. Scrub well with a stiff bristle brush and rinse thoroughly with hot water. It is necessary that a good cleaning operation be performed. If any of the abrasive material is allowed to remain in cylinder bores, it will rapidly wear new rings and cylinder bores in addition to bearings lubricated by contaminated oil. Bores should be swabbed several times with light engine oil and a clean cloth, then wiped with a clean, dry cloth. DO NOT clean cylinders with kerosene or gasoline. Clean remainder of cylinder block to remove excess material spread during honing operation.

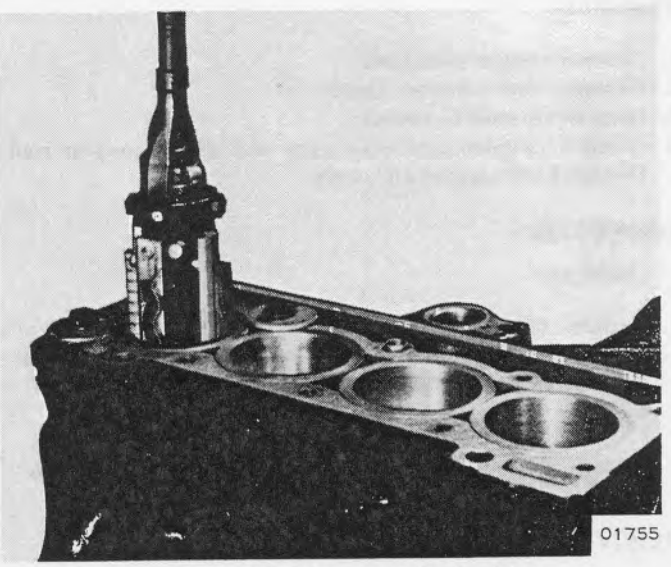

Figure 10. Honing Cylinder Liner

FLYWHEEL - "60"

REMOVAL

1. Remove engine from boat.
2. Remove inner transom plate.
3. Remove flywheel housing.
4. Remove coupler retaining nuts and slide coupler and flywheel off crankshaft studs.

INSPECTION

COUPLER

1. Failure of engine coupling assembly spline and/or universal splined shaft is caused by lack of sufficient lubrication at time of installation.
2. On initial installation, and whenever a stern drive unit is removed, engine coupling splines must be lubricated with New Multipurpose Lubricant (C-92-49588). Spline mating surfaces will wear very rapidly if installed dry.

FLYWHEEL

Check flywheel ring gear for worn or missing teeth.

INSTALLATION

1. Position coupler and flywheel on crankshaft studs and secure with elastic stop nuts.
2. Install flywheel housing and inner transom plate.
3. Install engine in boat.

FLYWHEEL - "80" and "90"

REMOVAL

1. Remove engine from boat.
2. Remove inner transom plate.
3. Use socket and extension thru coupler splines to remove stop nut which secures coupler.
4. Remove flywheel cover and flywheel housing with alternator stator. (Figure 1)

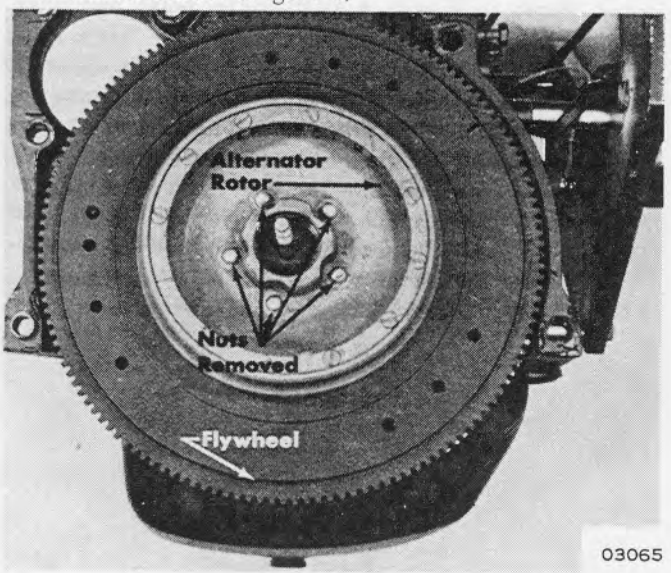

Figure 1. Flywheel Removal

5. Remove elastic stop nuts which secure alternator rotor to flywheel. Slide alternator rotor and flywheel off crankshaft studs.

INSPECTION

COUPLER

Failure of engine coupling assembly spline and/or universal splined shaft is caused by lack of sufficient lubrication at time of installation. On initial installation and whenever a stern drive unit is removed, be sure to lubricate engine coupling splines with New Multipurpose Lubricant (C-92-49588). The spline mating surfaces will wear very rapdily if installed dry.

FLYWHEEL

Check flywheel ring gear for worn or missing teeth.

INSTALLATION

1. Position flywheel and alternator rotor on crankshaft studs and secure with elastic stop nuts.
2. Install flywheel housing with alternator stator and flywheel cover.
3. Slide coupler into position in alternator stator on retaining bolt. Tighten coupler attaching nut thru coupler splines with socket and extension.
4. Install inner transom plate.
5. Install engine in boat.

CRANKSHAFT

REMOVAL

1. Remove engine from boat. Drain oil and water.
2. Remove inner transom plate and flywheel.
3. Install engine (inverted) on stand.
4. Remove oil pan and oil pump.
5. Remove cylinder block front cover as outlined.
6. Remove crankshaft sprocket retaining bolt and automatic chain tensioner and slide crankshaft sprocket off crank.
7. Remove main bearing and connecting rod bearing caps. Remove thrust washers from centermain bearing. (Figure 1)

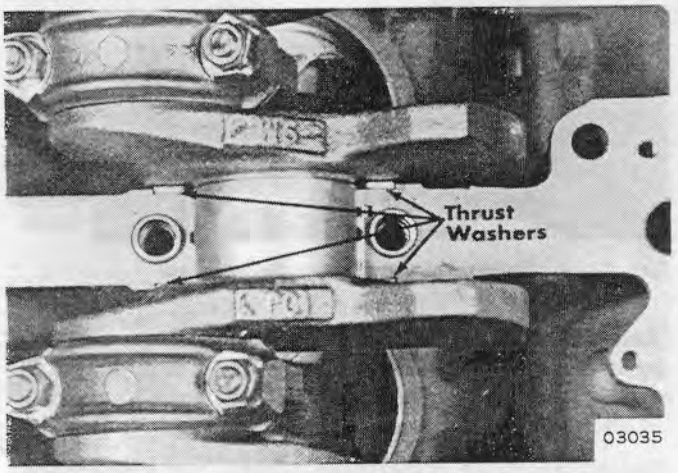

Figure 1. Thrust Washers

CLEANING

1. Handle crankshaft with care to avoid possible fractures or damage to finished surfaces.
2. Clean crankshaft with solvent, then blow out all oil passages with compressed air.
3. Use crocus cloth to remove any sharp edges or burrs which might damage oil seal during installation or cause premature seal wear.
4. Dress minor scores with an oil stone. If journals are severely marred or exceed wear limit, refinish to size for next undersize bearing.

REFINISHING JOURNALS

1. Refinish journals to give proper clearance with undersize bearings. If journal will not clean up with undersize bearings, replace crankshaft. Replacement crankshaft bearings are available in standard, .010" and .020" undersize (except "90" □standard and .010" undersize only□) for crank pins and main journals.
2. Always reproduce same journal shoulder radius that existed originally. Too small a radius results in fatigue failure of crankshaft. Too large a radius results in bearing failure due to radius ride of bearing.
3. After refinishing journals, chamfer oil holes, then polish journal with No. 320 grip polishing cloth and engine oil. Crocus cloth also may be used as a polishing agent.

INSTALLATION

1. With cylinder block inverted, carefully place crankshaft on upper main bearings in cylinder block.
2. Install thrust washers. (Figure 1)
3. Install main bearing and connecting rod bearing caps. Check bearing clearances as outlined, preceding.
4. Install crankshaft sprocket and automatic chain tensioner as described previously.
5. Install cylinder block front cover.
6. Install oil pump and oil pan.
7. Install rear seal as outlined, preceding.
8. Install flywheel and inner transom plate.
9. Install engine in boat.

BEARING and JOURNAL INSPECTION

1. Clean crankshaft and clear oil passages. In general, lower half of bearing shows greater wear and most distress from fatigue. If, upon inspection, lower half is acceptable, then upper half also is satisfactory. If lower half shows evidence of fatigue, distress, abrasion, erosion, scoring, etc, replace both upper and lower halves. Never replace one half only.
2. If running clearance of a bearing is too great with used inserts, install both upper and lower bearing halves then check crankshaft journals with a micrometer for out-of-round, taper or undersize. If out-of-round more than .001" (.025mm) or tapered, replace or recondition shaft.
3. Clearance increases from wear in main bearings is due not only to bearing wear, but also in part to crankshaft journal wear. Check these dimensions with a micrometer for out-of-round, taper or undersize. If journals exceed .001" (.025mm) out-of-round or taper, replace crankshaft or recondition to an undersize figure that allows installation of undersize presision type bearings. (Figure 2)
4. Check crankshaft for runout. Support crankshaft at front and rear main bearing journals in "V" blocks and indicate runout of both rear intermediate and front intermediate journals with a dial indicator. Runout limit of each of these journals is .002" (.051mm). If runout exceeds .002" (.051mm), repair or replace crankshaft.

A vs B = Vertical Taper
C vs D = Horizontal Taper
A vs C and B vs D = Out-of-Round

Check for Out-of-Round at Each End of Journal

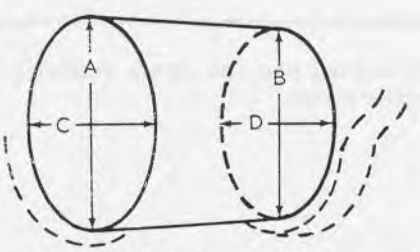

Figure 2. Crankshaft Journal Measurement

MAIN BEARING CLEARANCE

1. Main bearings are precision, insert type and do not utilize shims for adjustment. If clearances are excessive, a new standard or undersize bearing insert (both upper and lower halves) is required.
2. Plastigage, which may be used for checking clearances, is a wax-like plastic material that compresses evenly between bearing and journal surfaces without damaging either surface. (Figure 3) To obtain most accurate results with Plastigage, observe certain precautions. With engine out of boat and upside down, crankshaft rests on upper bearings, and total clearance can be measured between cap bearing and journal.

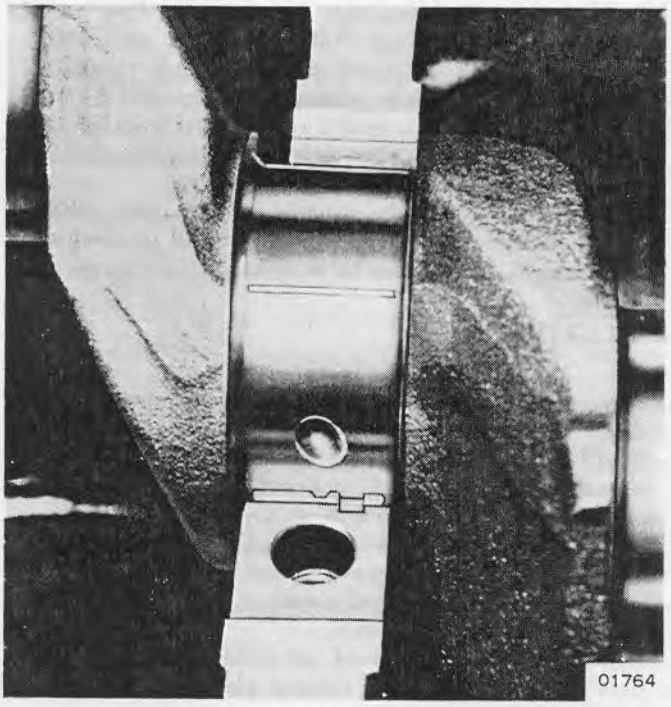

Figure 3. Plastigage on Journal

NOTE: To assure proper seating of crankshaft, remove rear main bearing oil seal and torque all bearing cap bolts. In addition, before checking fit of bearings, wipe surface of crankshaft journal and bearing clean of oil.

3. Starting with rear main bearing, remove bearing cap and wipe oil from journal and bearing cap.
4. Place a piece of Plastigage full width of bearing (parallel to crankshaft) on journal. (Figure 3)

CAUTION: Do not rotate crankshaft while Plastigage is between bearing and journal.

5. Install bearing cap and torque retaining bolts evenly to specifications.

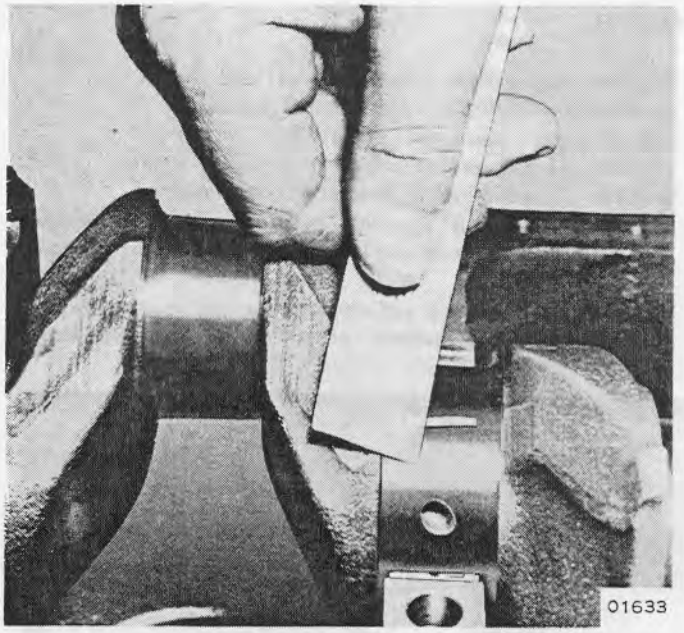

Figure 4. Measuring Plastigage

6. Remove bearing cap. Flattened Plastigage adheres to either bearing shell of journal. There is a graduated scale on edge of Plastigage packing envelope which is correlated in thousands of an inch.
7. Without removing Plastigage, check its compressed width (at widest point) with graduations on Plastigage envelope. (Figure 4)

NOTE: Normally, main bearing journals wear evenly and are not out-of-round, however, if bearing is being fitted to an out-of-round journal, be sure to fit to maximum diameter of journal. If bearing is fitted to minimum diameter of journal, and journal is out-of-round .001" (0.025mm) or more, interference between bearing and journal results in rapid bearing failure. If flattened Plastigage tapers toward middle or ends, there is a difference in clearance which indicates a taper, low spot or other irregularity of bearing or journal. Be sure to check journal with a micrometer, if flattened Plastigage indicates more than .001" (0.025mm) difference.

8. If bearing clearance is within specifications, the bearing insert is satisfactory. If clearance is not within these limits, replace insert. If clearance is still not within these limits, regrind crankshaft journal for use with next undersize bearing.
9. Proceed to next bearing. After all bearings have been checked, rotate crankshaft to check that no excessive drag exists.

CONNECTING ROD BEARING

CHECKING CRANKPIN CLEARANCE

1. Wipe bearing insert shell and crankpin clean of oil.
2. Place piece of Plastigage full width of bearing on crankpin (parallel to crankshaft). (Figure 5)

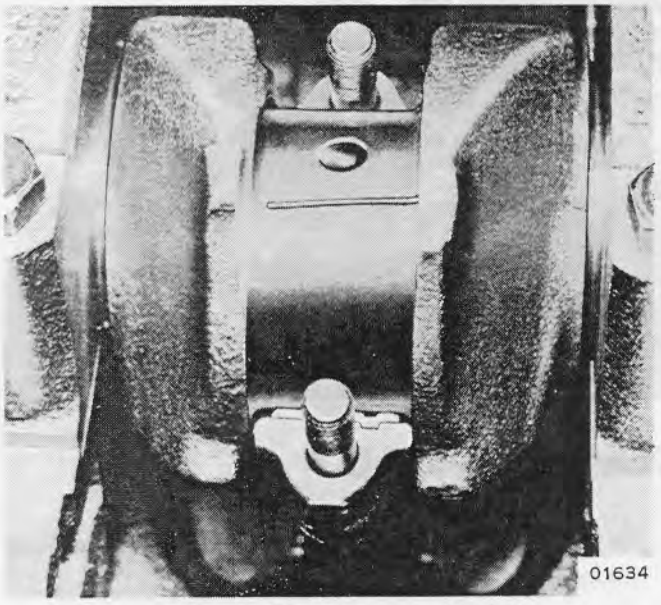

Figure 5. Plastigage on Crankpin

3. Reinstall bearing cap and torque retaining nuts evenly to specifications.

> **CAUTION: Do not turn crankshaft wtih Plastigage installed.**

4. Remove bearing cap and, without removing Plastigage, check its width at widest point with scale on Plastigage envelope. (Figure 6)

NOTE: If crankpin is out-of-round, be sure to fit bearing to maximum diameter of crankpin. If flattened plastic is not uniform from end-to-end in its width, crankpin or bearing is tapered, has a low spot or some other irregularity. Check crankpin with a micrometer for taper if flattened Plastigage indicates more than a .001" (0.025mm) difference.

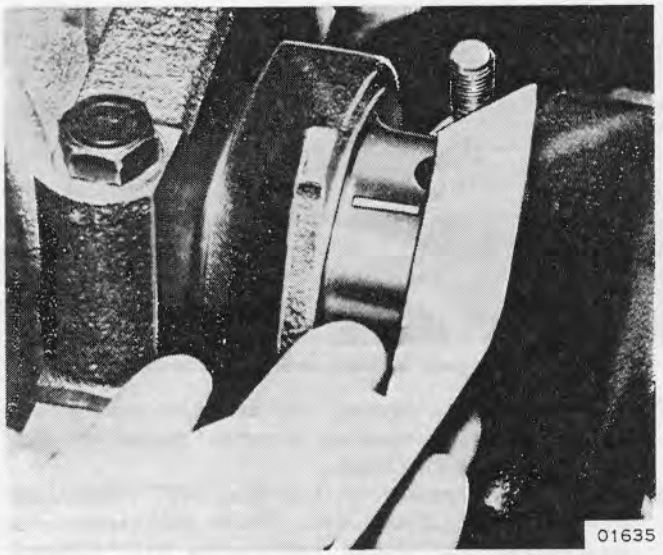

Figure 6. Measuring Plastigage on Crankpin

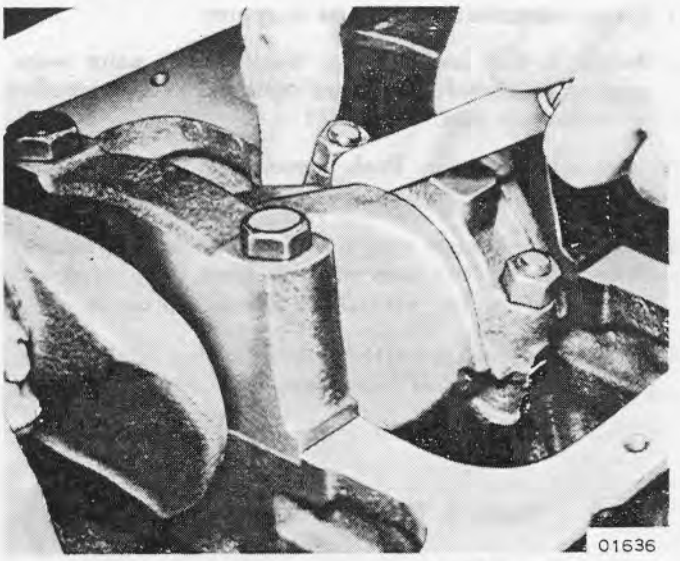

Figure 7. Checking Connecting Rod Side Clearance

5. New bearing shell insert clearance should be .003" (0.076mm) maximum and .001" (0.025mm) minimum. Rotate crankshaft after bearing adjustment to be sure that bearings are not too tight.
6. Check connecting rod and clearance between connecting rod cap and side of crankpin. (Figure 7)

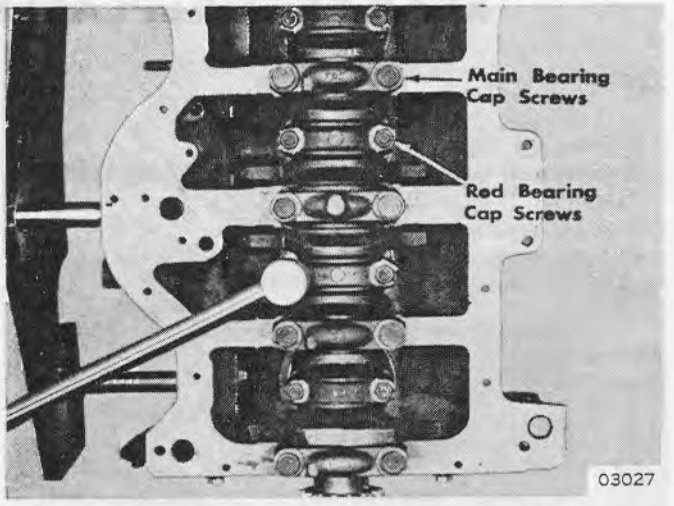

Figure 8. Torquing Connecting Rods

7. Be certain that all nuts are torqued to 21.7 ft. lb. (3mkg) and lock tabs are securely crimped. (Figure 8) Always use new lock tabs.
8. If clearances are not within these specifications, replace bearing with correct under-size bearing.

NOTE: Insert bearing shells are not adjustable, and no attempt should be made to adjust by filing the bearing caps.

CRANKSHAFT END PLAY

1. Force crankshaft toward rear of engine.
2. Install a dial indicator so that contact point rests against crankshaft flange and indicator axis is parallel to crankshaft axis. (Figure 1)
3. Zero dial indicator. Push crankshaft forward and note reading on dial.
4. If end play exceeds wear limit, replace thrust washers. If end play is less than minimum limit, inspect thrust washer faces for scratches, burrs, nicks or dirt.
5. Thrust washers are available in following thicknesses: .091" (2.30mm), .094" (2.40mm) and .096" (2.45mm).

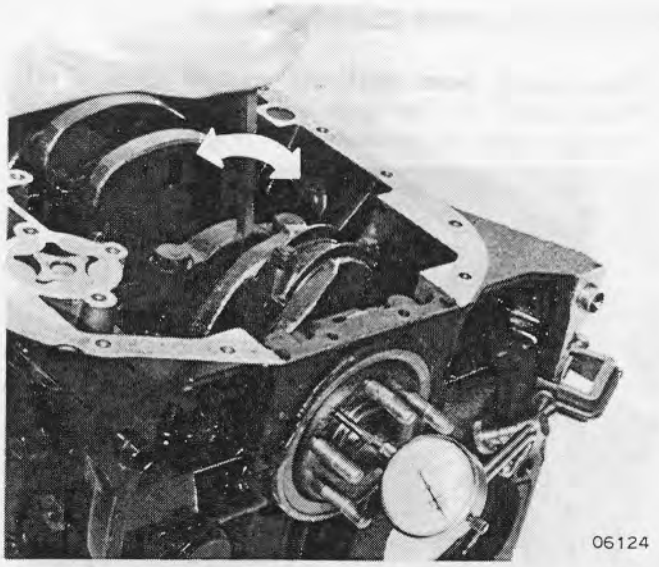

Figure 1. Checking Crankshaft End Play

REAR SEAL REPLACEMENT - "60"

REMOVAL

1. With flywheel and oil pan removed, loosen rear main bearing cap.
2. Loosen seal from around crankshaft and pull out seal.

INSTALLATION

1. Install new seal with lip facing toward inside of engine. Be sure that seal surfaces are not damaged (to prevent leakage).
2. Install rear main bearing cap and torque to specifications.
3. Install flywheel and oil pan as outlined.

REAR SEAL REPLACEMENT - "80" and "90"

REMOVAL

1. Remove oil pan and flywheel.
2. Remove rear main bearing and cap attaching bolts and drive cap. (Figure 2)
3. Pull out seal from around crankshaft.

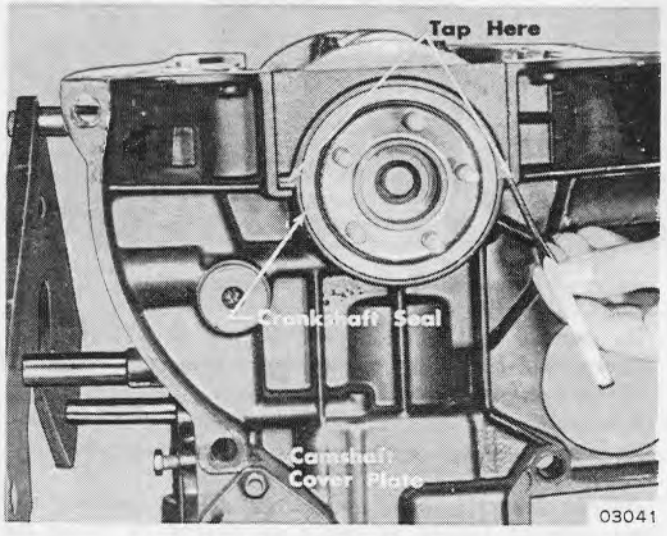

Figure 2. Rear Seal Replacement

INSTALLATION

1. Install new seal with lip facing toward inside of engine. Be sure that seal surfaces are not damaged (to prevent leakage). (Figure 2)

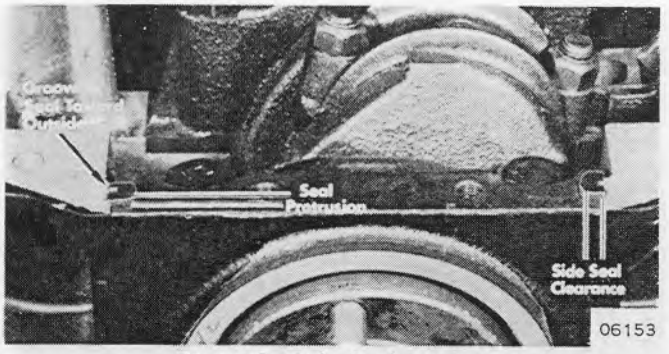

Figure 3. Side Seal Replacement

2. Check rear main bearing cap and side seal groove clearances by measuring between bottom of seal groove and cylinder block.
3. If side seal clearance is less than .197" (5mm), use 2 seals .211" (5.35mm) thick. If side seal clearance is greater than .197" (5mm), use 2 seals 2.11" (5.35mm) thick. (Figure 3)

4. Place side seals in rear main bearing cap with grooves in seals facing out.
5. Side seals should protrude approximately .008" (.203mm) above locating faces on cylinder block side.
6. Install rear main bearing caps with attaching bolts and torque to specifications.

CRANKSHAFT FRONT FLYWHEEL and ALTERNATOR "60' ONLY

REMOVAL

1. Remove screw and washer which secure alternator flywheel to crankshaft.
2. Install flywheel puller (C-91-38835A1) and remove flywheel. (Figure 4)
3. Remove alternator stator. (Figure 5)

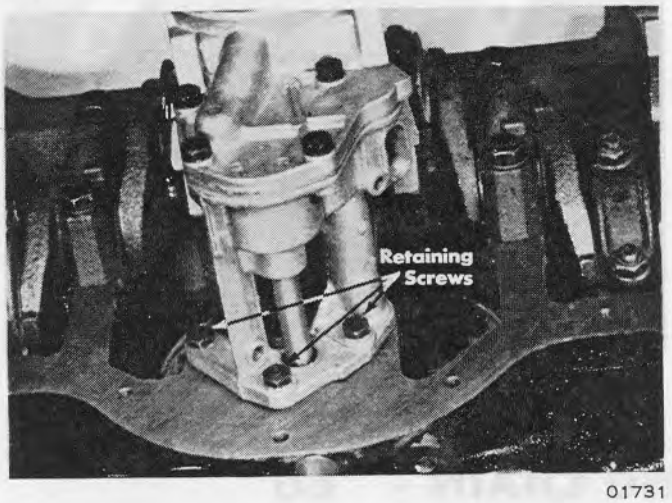

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Figure 4. Removing Alternator Flywheel

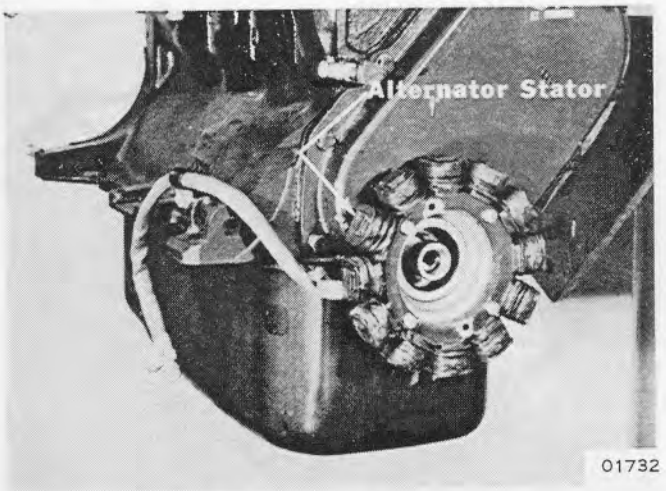

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Figure 5. Alternator Stator

INSTALLATION

1. If alternator problems are present, check stator as outlined in electrical section.
2. Install alternator stator. (Figure 5)
3. Coat timing cover with thin layer of grease.
4. Install alternator flywheel and secure with retaining screw and washer. (Figure 4)

CYLINDER BLOCK FRONT COVER - "60"

REMOVAL

1. Remove alternator flywheel and stator.
2. Remove cover attaching screws, then cover.
3. Clean gasket surfaces and discard gaskets.

INSTALLATION

1. Inspect oil seal in timing chain cover and replace if necessary. Lips must face toward timing chain. Use suitable mandrel and press into position. (Figure 6)
2. Install timing chain cover and gasket but do not tighten screws.
3. Install alternator flywheel on crankshaft to align oil seal.
4. Tighten screws securely and remove flywheel.
5. Install alternator stator and flywheel.

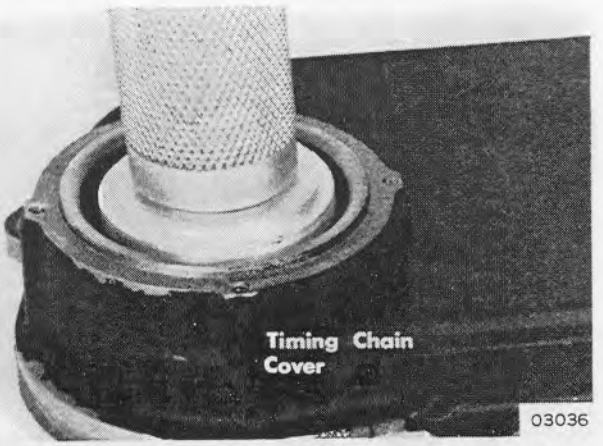

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Figure 6. Installing Oil Seal in Timing Chain Cover

CYLINDER BLOCK FRONT COVER - "80" and "90"

REMOVAL

1. Remove attaching bolts.
2. Remove cover.

INSTALLATION

1. Clean gasket surfaces.
2. Install cover with attaching bolts.

CHAIN TENSIONER

REMOVAL

NOTE: On MerCruiser "60", remove and replace alternator flywheel and stator for this operation.

1. Remove timing chain cover.
2. Compress chain tensioner and remove attaching screws.

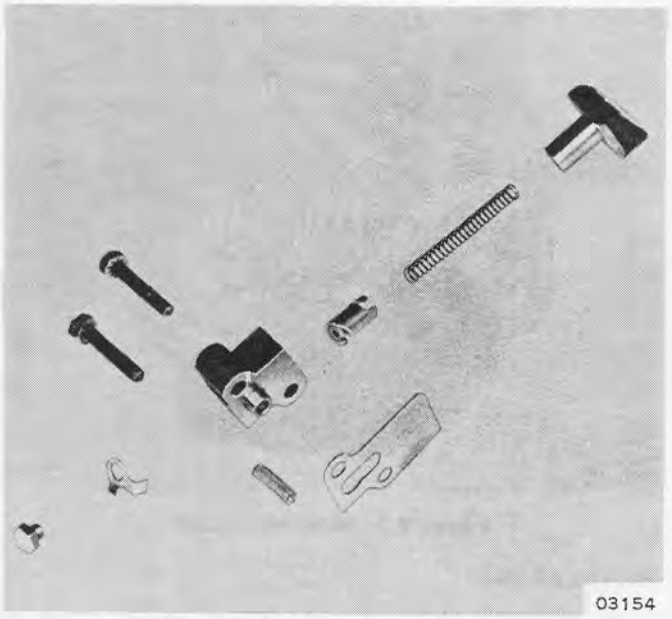


Figure 1. Chain Tensioner Components

INSTALLATION

1. Compress chain tensioner spring with No. 3 allen wrench. Turn clockwise until slide enters support.
2. Install chain tensioner.
3. Turn tensioner spring counterclockwise with allen wrench to clear lug which must enter automatic play take-up groove. (Figure 2)
4. Install screw at back of support and fold down new lock tab.
5. Install timing chain cover and gasket with Perfect Seal No. 4 (C-92-3422-1) and tighten screws.

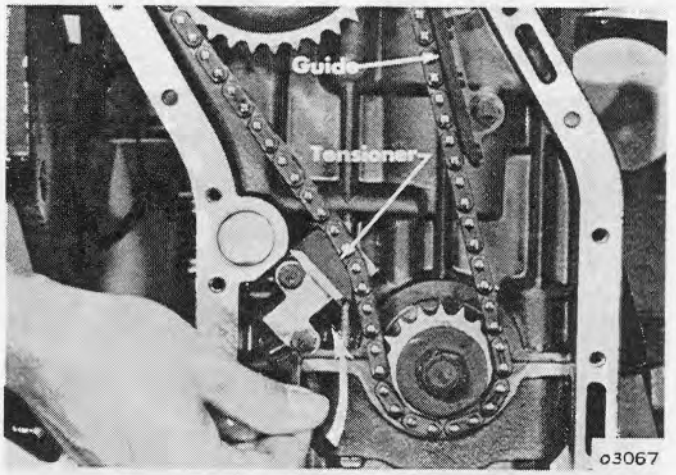


Figure 2. Installing Chain Tensioner

CAMSHAFT and TIMING CHAIN - "60"

REMOVAL

1. Remove alternator flywheel and stator.
2. Remove cylinder head.
3. Remove cylinder block front cover.

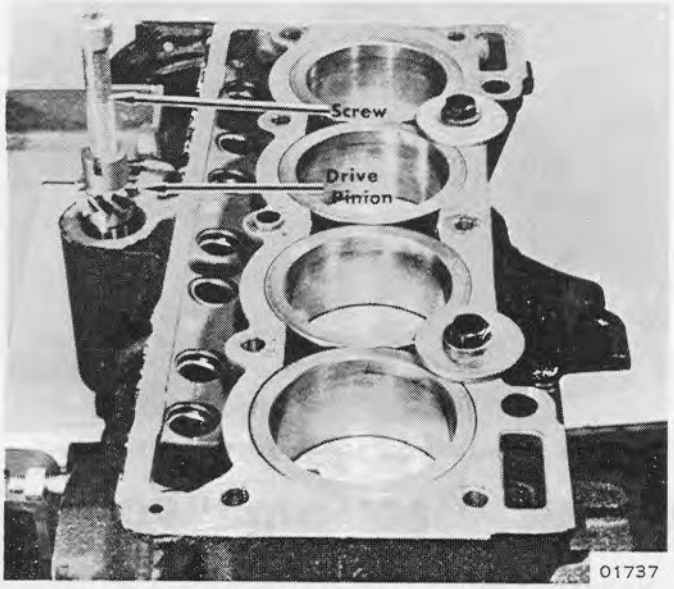


Figure 3. Removing Distributor Drive Pinion

4. Remove distributor and oil pump drive pinion with magnet or suitable screw. (Figure 3)
5. Remove tappets and place them in a rack in proper sequence for reassembly in original positions.

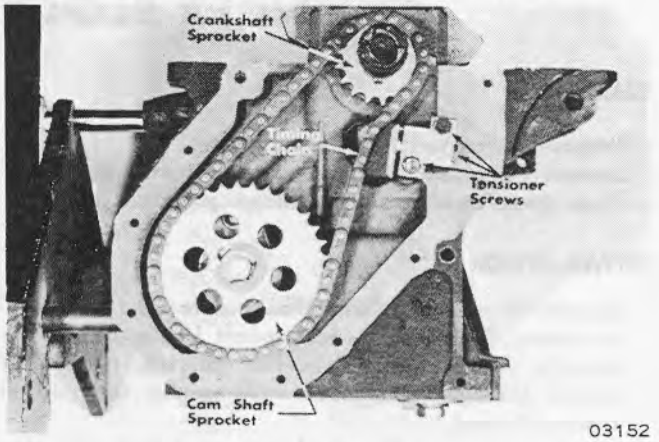


Figure 4. Removing Chain Tensioner

6. Unlock and remove screw at back of tensioner. Release tension on chain with No. 3 allen wrench, then remove chain tensioner assembly. (Figure 4)
7. Bend back tab washer and remove camshaft sprocket lock screw. (Figure 4)
8. Remove camshaft sprocket, crankshaft sprocket and timing chain. Remove key from crankshaft. (Fig. 4)
9. Remove 2 camshaft thrust plate screws and remove camshaft. (Figure 5)

NOTE: Support camshaft carefully when removing to prevent damage to camshaft or block.

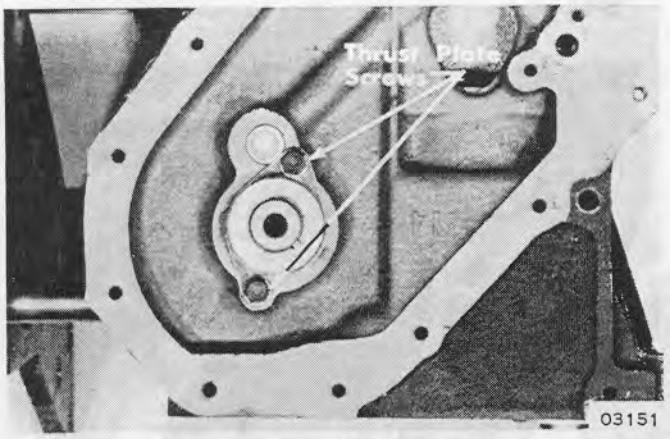


Figure 5. Removing Camshaft

INSTALLATION

1. Oil bearings and install camshaft.
2. Install thrust flange screws and tighten securely.
3. Install key in crankshaft.
4. Install drive sprocket on crankshaft.
5. Place camshaft sprocket in position and align the 2 sprocket reference marks with camshaft and crankshaft centerlines.
6. Remove camshaft sprocket and install timing chain and camshaft sprocket at the same time. Since chain is normally slack, reference mark line no longer aligns with camshaft axis. (Figure 6)

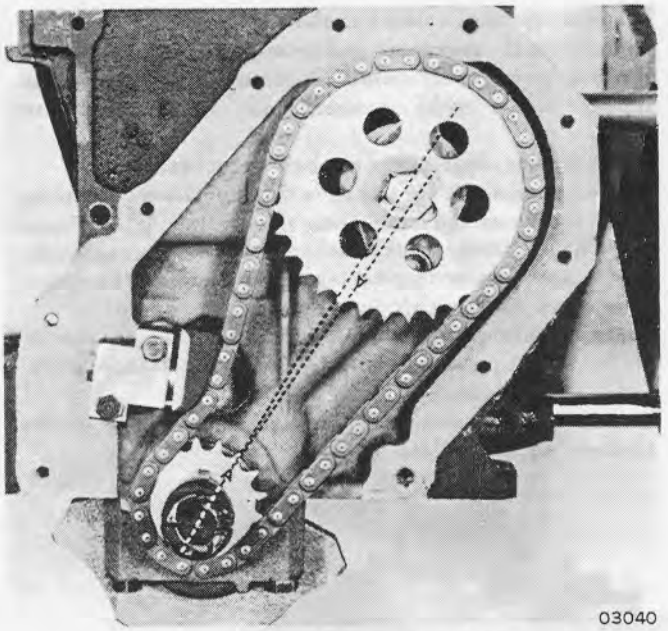


Figure 6. Installing Timing Chain

7. Tighten camshaft sprocket locking screw. In this position, valves on No. 4 cylinder both are partially open and No. 1 piston is in firing position.
8. Bend and lock camshaft screw tab.
9. Install cylinder block front cover.
10. Install cylinder head.
11. Turn crankshaft until No. 1 piston is at top-dead-center and in firing position. Valves on No. 4 cylinder both should be partially open and timing mark on alternator flywheel should be aligned with mark on timing chain cover.
12. With crankshaft in this position, install drive pinion so that slot in gear is at right angle to engine center line, and large offset is toward dipstick. (Figure 7)
13. Remove distributor cap and turn rotor so that it is pointed at No. 1 spark plug terminal of distributor cap.
14. Place distributor body in position in cylinder block. It may be necessary to turn rotor slightly to align drive slot.
15. Turn distributor body slightly until points just open and tighten distributor hold-down clamp.
16. Reinstall distributor cap and check that rotor is pointing at No. 1 spark plug terminal.

NOTE: Some engines have large offset 180° from dipstick.

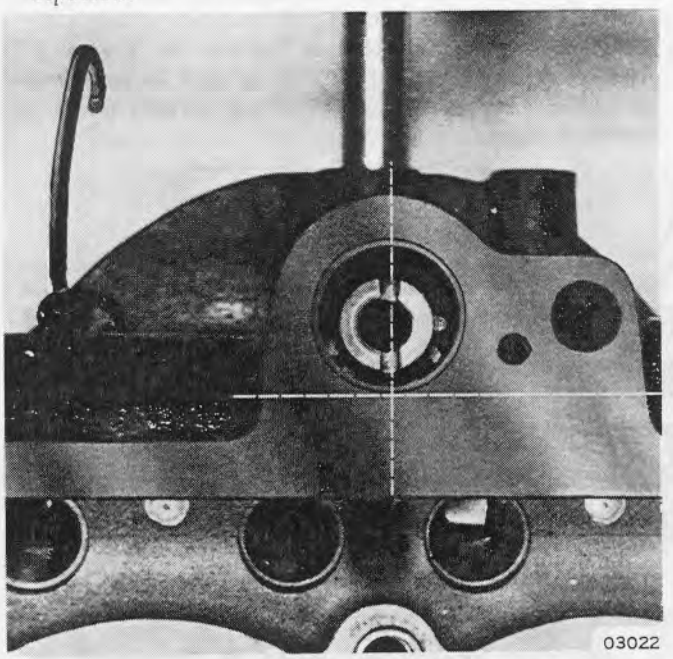


Figure 7. Installing Distributor Drive Pinion

CLEANING and INSPECTION

1. Inspect bearing surfaces, cams and drive sprocket.
2. Check flange clearance with a feeler gauge. (Figure 8) If clearance is excessive, replace thrust plate and/or spacer.

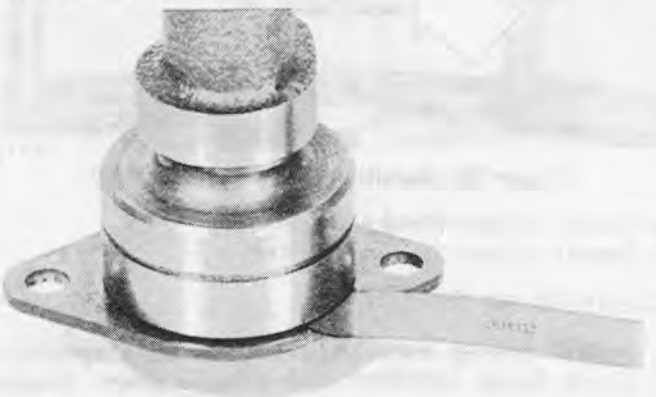


Figure 8. Checking Flange Clearance

CAMSHAFT, TIMING CHAIN and SPROCKETS - "80" and "90"

REMOVAL

1. Remove cylinder head as outlined.
2. Remove cylinder block front cover.
3. Remove crankshaft sprocket retaining bolt and automatic chain tensioner.
4. Remove distributor pinion gear.
5. Remove camshaft thrust bearing bolts thru holes in camshaft sprocket. (Figure 6)
6. Pull camshaft forward while guiding lobes over journal surfaces to prevent damage to cylinder block. It may be necessary to use a puller tool to dislodge crankshaft sprocket. Pull crankshaft sprocket and camshaft forward together for removal.
7. With crankshaft position as shown in Figure 11, install drive pinion so that slot in gear is positioned as shown in Figure 9 or 10. Place largest offset on camshaft side.

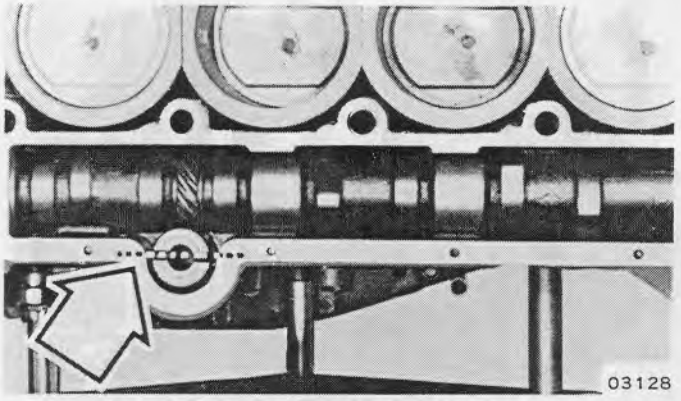


Figure 9. Installing Drive Pinion - "80"

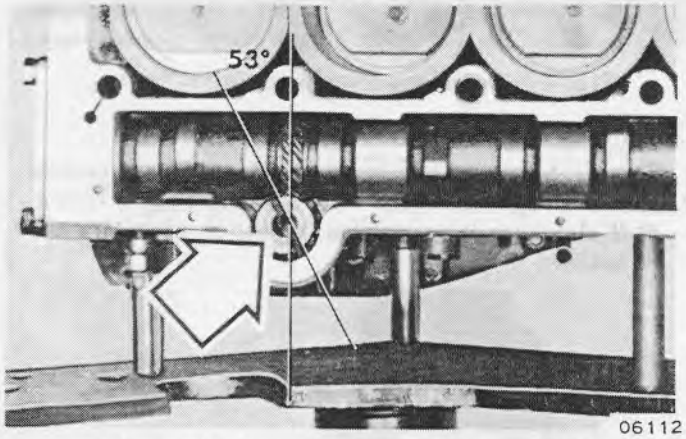


Figure 10. Installing Drive Pinion - "90"

8. Install cylinder block front cover.
9. Install cylinder head as outlined.

CLEANING and INSPECTION

1. Inspect bearing surfaces, cams and drive sprocket.
2. Check flange clearance with a feeler gauge. (Figure 12) If clearance is excessive, replace thrust plate and/or spacer.

Figure 12. Checking Flange Clearance

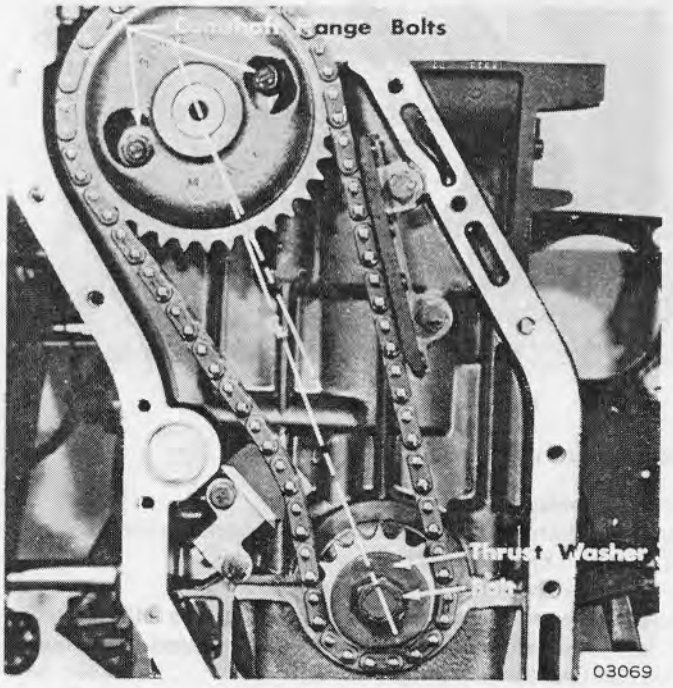
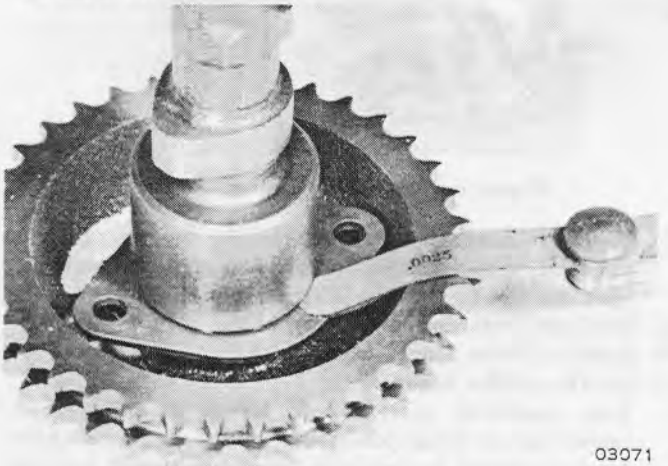


Figure 11. Aligning Timing Marks and Installing Timing Chain

INSTALLATION

1. Oil bearings and install camshaft.
   Install key in crankshaft and rotate until key is at top.
2. Do not completely install camshaft. Align sprocket timing marks with camshaft and crankshaft center lines.
3. Place timing chain over camshaft sprocket.
4. Place crankshaft sprocket on timing chain, aligning mark with cam and crankshaft centerline (℄). (Figure 11) While fitting crankshaft sprocket to crankshaft, use a soft mallet to seat sprocket and, at the same time, push on camshaft until sprocket is seated.
5. Install crankshaft thrust washer and bolt and torque to 45 ft. lbs. (6.2mkg). Install 2 camshaft flange bolts and tighten securely.
6. Install chain tensioner. This will cause timing marks to move off centerline.



CAMSHAFT GEAR REPLACEMENT - "80" and "90"

REMOVAL

1. Place camshaft and sprocket assembly under a press.
2. Support sprocket with ring of same diameter.
3. Press camshaft out of sprocket with a mandrel. (Figure 13)

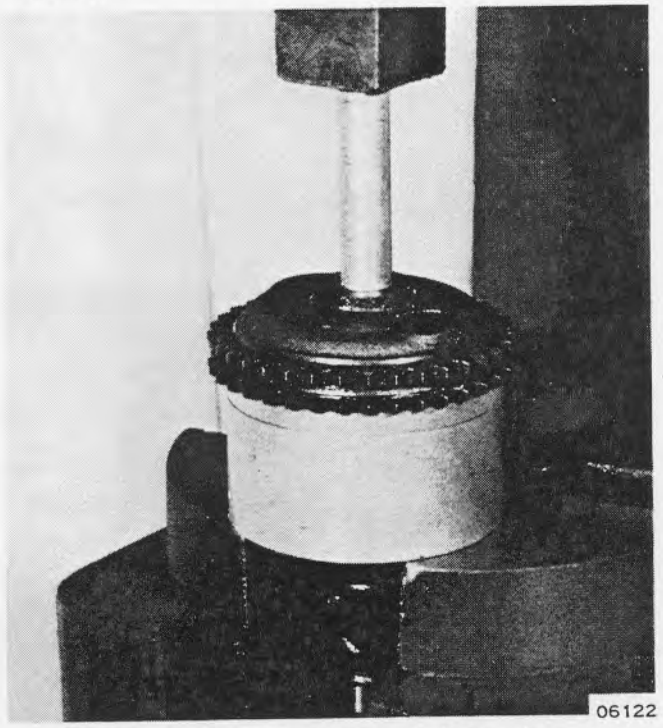


Figure 13. Removing Camshaft Sprocket

INSTALLATION

1. Place camshaft and sprocket under a press.
2. Support camshaft under first bearing shoulder.
3. Press sprocket onto camshaft. (Figure 14)
4. Check thrust bearing clearance.

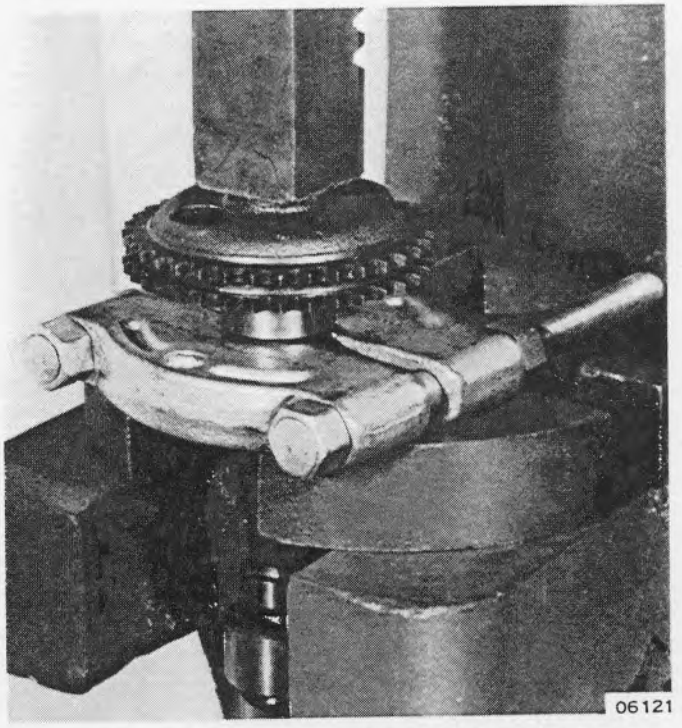


Figure 14. Installing Camshaft Sprocket

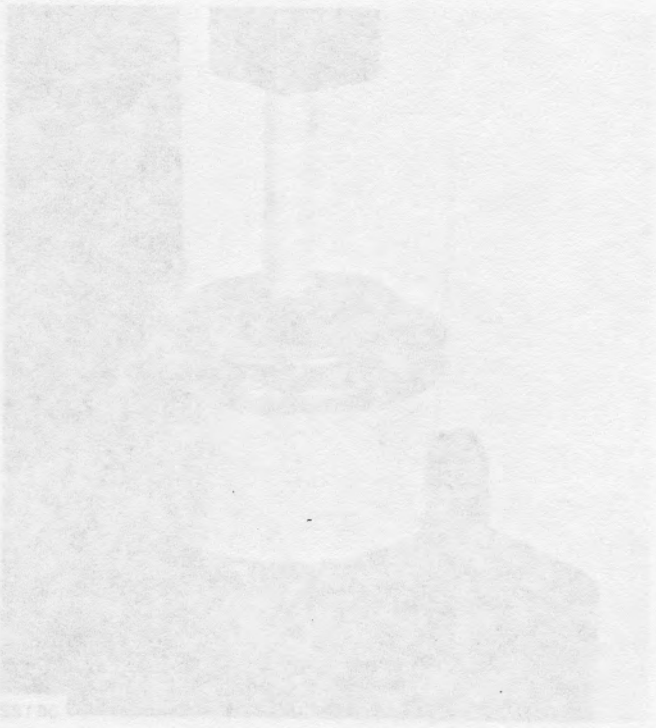
CYLINDER BLOCK

CLEANING

1. If engine is disassembled, thoroughly clean block with solvent .
2. Remove old gasket material from all machined surfaces.
3. Remove all pipe plugs that seal oil passages, then clean out all passages.
4. Blow out all passages, bolt holes, etc, with compressed air. Make sure that threads in cylinder head bolt holes are clean. Dirt in threads may cause binding and result in a false torque reading. Use a tap to true-up threads and to remove any deposits.
5. Thoroughly clean grooves in crankshaft bearings and bearing retainers.

INSPECTION

1. After it is thoroughly cleaned, check block for cracks. Minute cracks (not visible to naked eye) may be detected by coating suspected area with mixture of 25% kerosene and 75% light engine oil.
2. Wipe part dry and immediately apply coating of zinc oxide dissolved in wood alcohol. If cracks are present, coating will become discolored at defective area. Replace block if cracked.
3. Check all machined gasket surfaces for burrs, nicks, scratches and scores. Remove minor imperfections with an oil stone.
4. Check cylinder block for flatness of cylinder head gasket surface, following procedure and specifications recommended for cylinder head.



SECTION 5 - ENGINE

MERCRUISER

PART C - ENGINE MECHANICAL, V-8 GM

MERCURY MARINE

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ENGINE MECHANICAL - V-8 GM ENGINES

This Section Contains Repair Information for the Following V-8 Engines:

MerCruiser 190 Stern Drive Engine	283 Cubic Inch
MerCruiser 225 Stern Drive and Inboard	327 Cubic Inch
MerCruiser 250 Stern Drive and Inboard	327 Cubic Inch
MerCruiser 270 Stern Drive and Inboard	350 Cubic Inch
MerCruiser 310 Stern Drive	409 Cubic Inch
MerCruiser 325 Stern Drive and Inboard	427 Cubic Inch
MerCruiser 390 Stern Drive and Inboard	482 Cubic Inch

TOOLS

All "J-" (Special) Tools Listed in This Section May Be Purchased from:
Kent-Moore, Inc.
28635 Mound Road
Warren, Mich. 48089

GENERAL

Repair procedures are basically the same on all models. Any variations in repair procedure will be noted in the service instructions.

Crankshaft has 5 main bearings and camshaft has 5 bearings.

Full pressure lubrication thru oil filter is furnished by gear-type oil pump. Distributor, driven by a helical gear on camshaft, drives the oil pump. Main oil gallery feeds oil thru drilled passages to camshaft and crankshaft to lubricate bearings. Valve lifter oil gallery feeds valve lifters, which, thru hollow push rods, feed individually mounted rocker arms.

Design of boat and particular repair procedure may require that engine be removed from boat. Engine should be placed on engine stand for major repairs.

ROCKER ARM COVER

REMOVAL

1. Remove rocker arm cover attaching screws.
2. Disconnect crankcase ventilation hoses.

CAUTION: DO NOT pry rocker arm cover loose. Gaskets, which adhere to cylinder head and rocker arm cover, may be sheared by bumping end of rocker arm cover from the rear with palm of hand or a rubber mallet.

3. Disconnect temperature wire from left rocker arm cover clips.
4. Remove rocker arm cover.

INSTALLATION

1. Clean gasket surfaces on cylinder head and rocker arm cover with degreaser. Install a new gasket with rocker arm cover and torque to specifications.
2. Connect temperature wire on left rocker arm cover.
3. Connect crankcase ventilation hoses (as required).
4. Start engine and check for leaks.

EXHAUST MANIFOLDS

REMOVAL

1. Left (port) manifold
   a. Remove exhaust tube and water hose from left manifold.
   b. Remove screws which secure left exhaust manifold to cylinder head.
2. Right (starboard) manifold
   a. Remove exhaust tube and water hose from right manifold.
   b. Remove screws which secure right exhaust manifold to cylinder head.

CLEANING and INSPECTION

1. Clean gasket material from all surfaces and wash parts in solvent.
2. Install new gaskets and screws which secure manifold to cylinder head. Torque to specifications.
3. Install exhaust tubes and water hoses.

INSTALLATION

1. Clean mating surfaces and check manifold for cracks. Replace manifold, if cracked.
2. Inspect all parts carefully. Machined surfaces must be clean and free of all marks or deep scratches, or water leaks may result.
3. Check water passages for sand, silt or foreign material. Passages must be clean for efficient cooling.
4. Pipe plugs may be removed from exhaust manifold elbow and exhaust pipe elbow, if more thorough inspection is desired.

INTAKE MANIFOLD

REMOVAL

1. Remove flame arrestor, crankcase ventilator and water cooling hoses to thermostat housing.
2. Disconnect carburetor linkage, fuel lines, temperature sending unit and coil primary wires. Disconnect coil to distributor secondary wire.
3. Remove distributor cap and mark rotor position with chalk, then remove distributor. Note distributor position in cylinder block.
4. Remove oil filler bracket, if required.
5. Remove manifold attaching bolts, then remove manifold and carburetor as an assembly. Discard gaskets and seals.
6. If manifold is to be replaced, transfer:
   Carburetor and carburetor mounting studs.
   Temperature sending unit.
   Water outlet and thermostat (use new gasket).

INSTALLATION

1. Clean gasket and seal surfaces on manifold, block and cylinder heads.
2. Install manifold seals on block and gaskets on cylinder heads. Use sealer at water passages and where seals butt to gaskets.
3. Install manifold and torque bolts to specifications in the sequence outlined on torque sequence chart. (Figure 1 or 2).
4. Install distributor, positioning rotor at chalk mark, then install distributor cap.
5. Connect:
   - Coil
   - Temperature sending unit
   - Fuel lines
   - Carburetor linkage
   - Water pump by-pass at water pump (use new gasket).
6. Adjust choke and carburetor linkage as outlined.
7. Start engine, adjust ignition timing and carburetor idle speed and mixture and check for leaks.

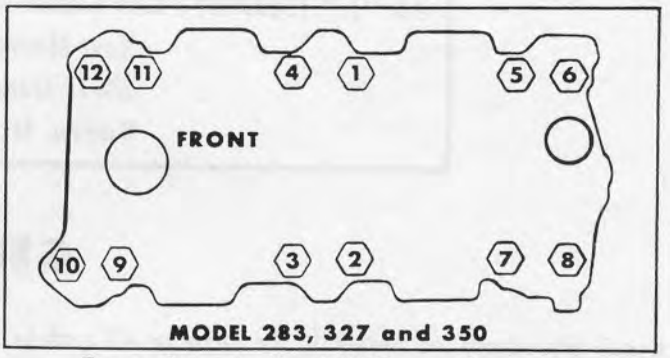
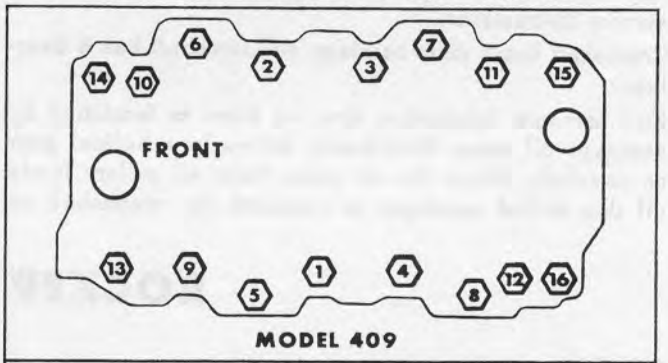


Figure 1. Intake Manifold Torque Sequence



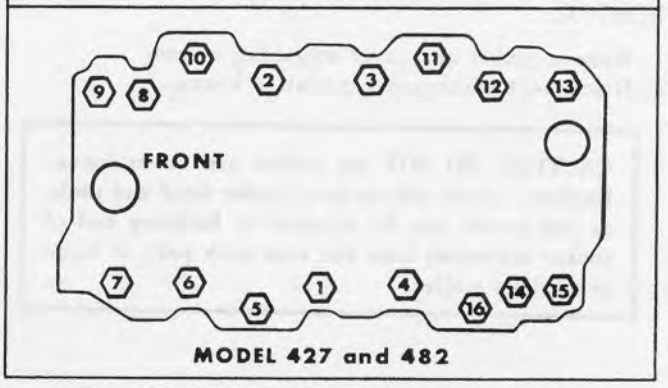


Figure 2. Intake Manifold Torque Sequence

VALVE MECHANISM

REMOVAL

1. Remove rocker arm covers as outlined.
2. Remove rocker arm nuts, rocker arm balls, rocker arms and push rods.

   NOTE: Place rocker arms, rocker arm balls and push rods in a rack for reinstallation in the same locations.

INSTALLATION

NOTE: When installing new rocker arms and/or rocker arm balls, coat bearing surfaces of rocker arms and rocker arm balls with Molykote or equivalent.

1. Install push rods. Be sure push rods seat in lifter socket.
2. Install rocker arms, rocker arm balls and rocker arm nuts. Tighten rocker arm nuts until all lash is eliminated.

   NOTE: (409 Engine Only) Exhaust valve push rods are longer than inlet valve push rods. Install push rods in their respective bores with the hardened tip (yellow color code end) up.

ADJUSTMENT

Valve lash can be adjusted either with engine stopped or running. See following procedures.

1. VALVE ADJUSTMENT - ENGINE STOPPED (EXCEPT 409)

With valve cover removed, adjust valves when lifter is on base circle of camshaft lobe as follows:

a. Crank engine with starter or turn over in normal direction of rotation until mark on torsional damper lines up with center "O" mark on timing tab fastened to crankcase front cover, and engine is in No. 1 firing position. This may be determined by placing fingers on No. 1 valve as mark on damper comes near "O" mark on timing mark. If valves move as mark comes up to timing tab, engine is in No. 6 firing position and should be turned over one more time to reach No. 1 position.

b. With engine in No. 1 firing position as determined above, the following valves may be adjusted.

Left Hand (Standard) Rotation Engines

Exhaust - 1-3-4-8
Intake - 1-2-5-7

Right Hand Rotation (Opposite) Engines

Exhaust - 1-2-5-7
Intake - 1-3-4-8

c. Back out adjusting nut until lash is felt at push rod, then turn in adjusting nut until all lash is removed. This can be determined by checking push rod side play while turning adjusting nut until all play is removed. (Figure 3)

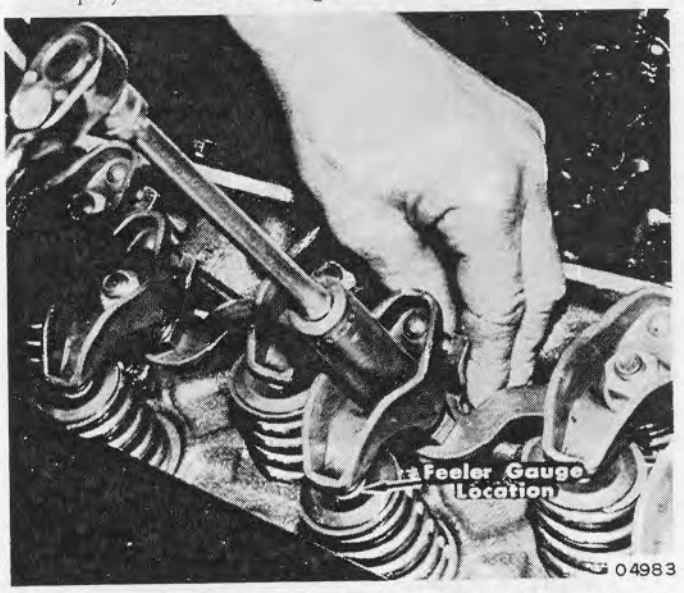


Figure 3. Valve Adjustment - Engine Stopped

HYDRAULIC LIFTERS then can be adjusted by tightening adjustment nut an additional ¾-turn to place plunger in center of its travel. No other adjustment is required.

d. Crank engine one revolution until pointer "O" mark and torsional damper mark are again in alignment. This is No. 6 firing position. With engine in this position, the following valves may be adjusted as previously outlined.

Left Hand (Standard) Rotation Engines

Exhaust - 2-5-6-7
Intake - 3-4-6-8

Right Hand (Opposite) Rotation Engines

Exhaust - 3-4-6-8
Intake - 2-5-6-7

e. Install rocker arm covers as outlined.
f. Adjust carburetor idle speed and mixture.

2. VALVE ADJUSTMENT - ENGINE RUNNING

a. Hydraulic Lifters
Following procedure is performed with engine running:

(1) After engine has been normalized, remove valve covers and install a reworked valve cover (cut top out of a used valve cover) and gasket on cylinder heads to prevent oil from running out. (Figure 4)

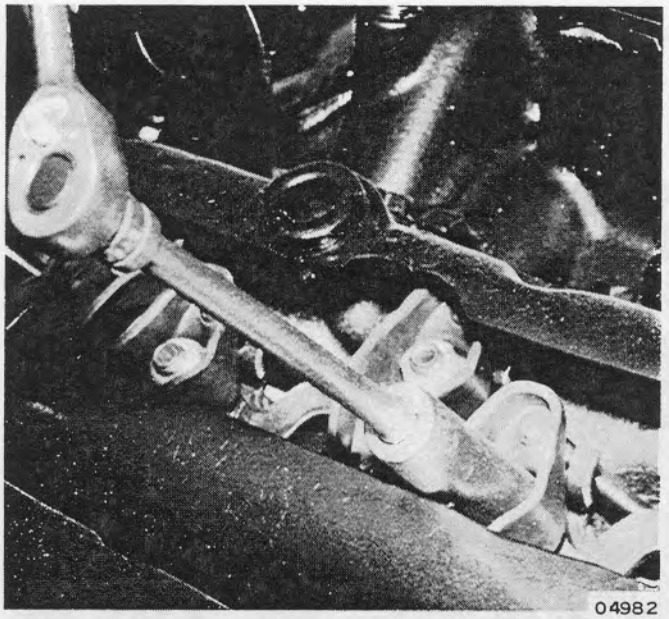


Figure 4. Valve Adjustment - Engine Running

(2) With engine running at idle, back valve rocker arm nuts off (one at a time) until valve rocker arm starts to clatter.
(3) Turn rocker arm nut down until clatter just stops. This is zero lash position.
(4) Turn nut down ¼ additional turn and pause 10 seconds until engine runs smoothly. Repeat additional ¼ turns, pausing 10 seconds each time, until nut has been turned down ¾-turn from the zero lash position.

NOTE: This ¾-turn preload adjustment must be done slowly to allow lifter to adjust itself, thus preventing possibility of interference between inlet valve head and top of piston which might result in internal damage and/or bent push rods.

(5) Repeat Steps 2-3-4 to adjust other valves. Remove reworked valve covers and install new gaskets and covers.
(6) Adjust carburetor.

b. Mechanical Lifters

Following procedure is performed with engine at normal operating temperature:

(1) After engine has been normalized, remove valve cover and install valve cover with cut-out top to prevent oil from running out.
(2) With engine running at idle, back off valve rocker arm nut until valve rocker arm starts to clatter.
(3) Insert feeler gauge of correct thickness ("Specifications", Section 8) between rocker arm and valve stem.
(4) Turn rocker arm nut down until light drag is felt on feeler gauge. This is correct valve lash.

NOTE: Care must be taken to distinguish between intake valves and exhaust valves, as each requires different clearances.

(5) Repeat Steps 2, 3 and 4 to adjust rest of valves.
(6) Install valve cover(s) and new gasket(s).
(7) Adjust carburetor.

HYDRAULIC VALVE LIFTERS

Hydraulic valve lifters require little attention. Lifters are extremely simple in design, readjustments are not necessary and servicing requires only that care and cleanliness be exercised in the handling of parts.

LOCATING NOISY LIFTERS

Locate a noisy valve lifter by using a piece of garden hose approximately 4 ft. (1.2m) in length. Place one end of hose near end of each intake and exhaust valve, with other end of hose to the ear. In this manner, the sound is localized, making it easy to determine which lifter is at fault.

Another method is to place a finger on face of valve spring retainer. If lifter is not functioning properly, a distinct shock will be felt when valve returns to its seat.

General types of valve lifter noise are as follows:

1. Hard rapping noise -- Usually caused by plunger becoming tight in bore of lifter body so that return spring cannot push plunger back up to working position. Probable causes are:
   a. Excessive varnish or carbon deposit, causing abnormal stickiness.
   b. Galling or "pick-up" between plunger and bore of lifter body, usually caused by an abrasive piece of dirt or metal wedged between plunger and lifter body.
2. Moderate rapping noise -- Probable causes are:
   a. Excessively high leakdown rate.
   b. Leaky check valve seat.
   c. Improper adjustment.
3. General noise throughout valve train -- This will, in most cases, be a definite indication of insufficient oil supply or improper adjustment.
4. Intermittent clicking -- Probable causes are:
   a. A miscroscopic piece of dirt momentarily caught between ball seat and check valve ball.
   b. In rare cases, ball itself may be out-of-round or have a flat spot.
   c. Improper adjustment.

In most cases, where noise exists in one or more lifters, all lifter units should be removed, disassembled, cleaned in solvent, reassembled and reinstalled in engine. If dirt, corrosion, carbon, etc, is shown to exist in one unit, it more likely exists in all the units, thus it would only be a matter of time before all lifters caused trouble.

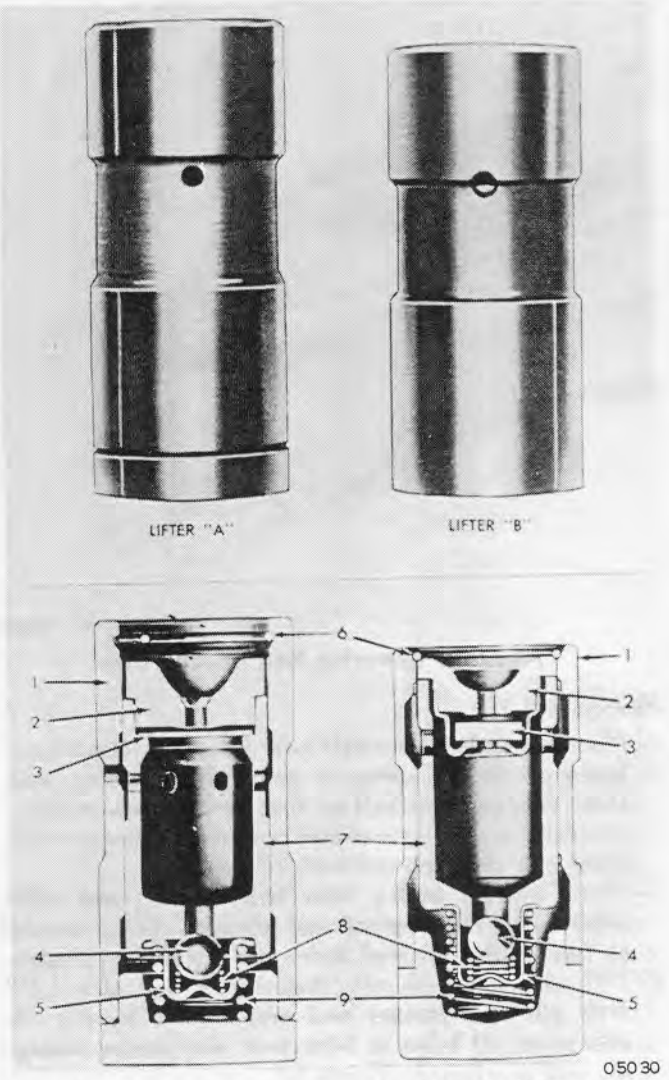
REMOVAL

1. Remove intake manifold as outlined.
2. Remove valve mechanism as outlined.
3. Remove valve lifters.

NOTE: Place valve lifters in a rack so that they may be reinstalled in same location.

DISASSEMBLY

1. Hold plunger down with a push rod and remove push rod seat retainer with blade of small screwdriver.
2. Remove push rod seat and metering valve (lifter "A") or push rod seat and inertia valve assembly (lifter "B"). (Figure 5)



1 - Lifter Body
2 - Push Rod Seat
3 - Metering Valve (Lifter A)
Inertia Valve (Lifter B)
4 - Check Ball
5 - Check Ball Retainer
6 - Push Rod Seat Retainer
7 - Plunger
8 - Check Ball Spring
9 - Plunger Spring

Figure 5. Hydraulic Valve Lifters

3. Remove plunger, ball check valve assembly and plunger spring.
4. Remove ball check valve and spring by prying ball retainer loose from plunger with blade of a small screwdriver. (Figure 6)

CLEANING and INSPECTION

Thoroughly clean all parts in cleaning solvent and inspect them carefully. If any parts are damaged or worn, entire lifter assembly should be replaced. If lifter body wall is scuffed or worn, inspect cylinder block lifter bore. If bottom of lifter is scuffed or worn, inspect camshaft lobe. If push rod seat is scuffed or worn, inspect push rod,

NOTE: Inertia valve and retainer (lifter "B") (Figure 5) should not be removed from push rod seat. To check valve, shake push rod seat and inertia valve assembly, and valve should move.

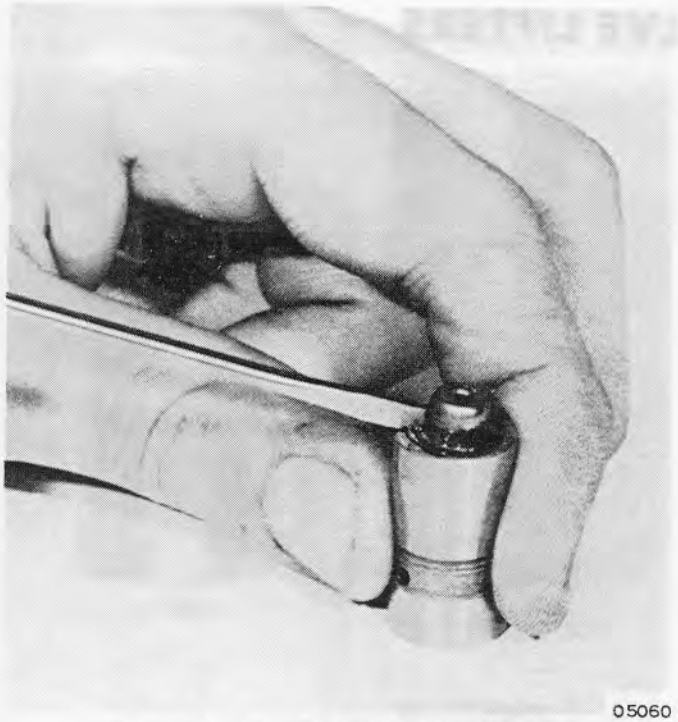


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Figure 6. Removing Ball Check Valve

REASSEMBLY

1. Place check ball on small hole in bottom of plunger.
2. Insert check ball spring on seat in ball retainer and place retainer over ball so that spring rests on ball. Carefully press retainer into position in plunger with blade of a small screwdriver. (Figure 7)
3. Place plunger spring over ball retainer and slide lifter body over spring and plunger, being careful to line up the oil feed holes on lifter body plunger.
4. Fill assembly with oil, then insert end of a 1/8" drift pin into plunger and press down heavily. At this point, oil holes in lifter body and plunger assembly will be aligned. (Figure 8)

05022

Figure 7. Installing Ball Check Valve

CAUTION: Do not attempt to force or pump the plunger.

5. Insert a 1/16" drift pin thru both oil holes to hold plunger down against lifter spring tension. (Figure 8)

   NOTE: On lifter "B" (Figure 5) drift pin must not extend inside plunger.

6. Remove 1/8" drift pin and refill assembly with oil.
7. Install metering valve and push rod seat (lifter "A") or push rod seat and inertia valve assembly (lifter "B"). (Figure 5)
8. Install push rod seat retainer, press down in push rod seat and remove 1/16" drift pin from oil holes. Lifter now is completely assembled, filled with oil and ready for installation.

   NOTE: Before installing any new lifters, coat bottom of lifter with Molykote or equivalent.

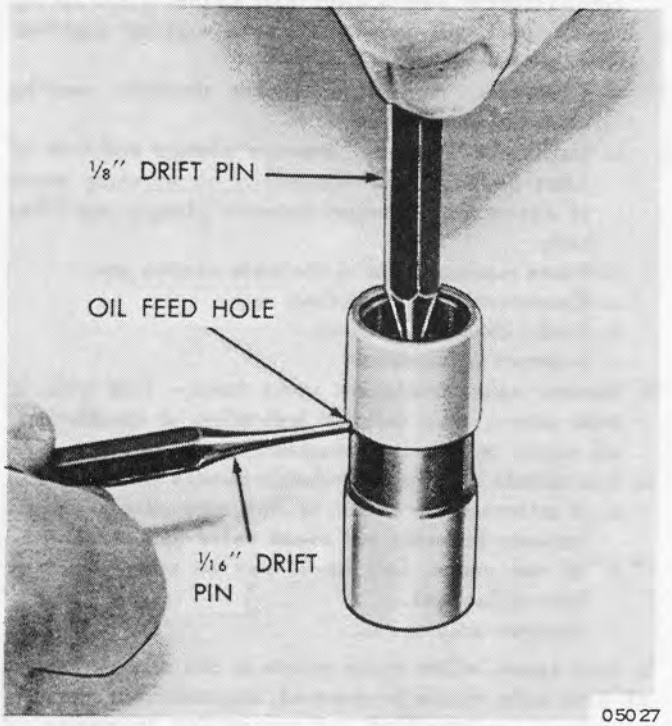

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Figure 8. Assembling Hydraulic Lifters

INSTALLATION

1. Install valve lifters.

   NOTE: Whenever new valve lifters are being installed, coat foot of valve lifters with Molykote or equivalent.

2. Install intake manifold as outlined.
3. Install and adjust valve mechanism as outlined.

Two types of hydraulic lifters are used. Both types operate on the same principle and are serviced basically in the same manner. Complete lifter assemblies are interchangeable, but parts from one lifter are not interchangeable with another. Both lifters are easily identified by outside configuration of lifter body. Identify them as lifter "A" and lifter "B". (Figure 4)

VALVE STEM OIL SEAL and/or VALVE SPRING

REPLACEMENT

1. Remove rocker arm cover as outlined.
2. Remove spark plug, rocker arm and push rod on cylinder(s) to be serviced.
3. Apply compressed air to spark plug hole to hold valves in place.

   NOTE: A tool to apply air to the cylinder is available thru local jobbers or spark plug may be used. Chisel spark plug as shown, then drive porcelain out of plug by tapping center electrode against a hard block. Using a 3/8" pipe tap, cut threads in remaining portion of spark plug and assemble as shown. (Figure 9)

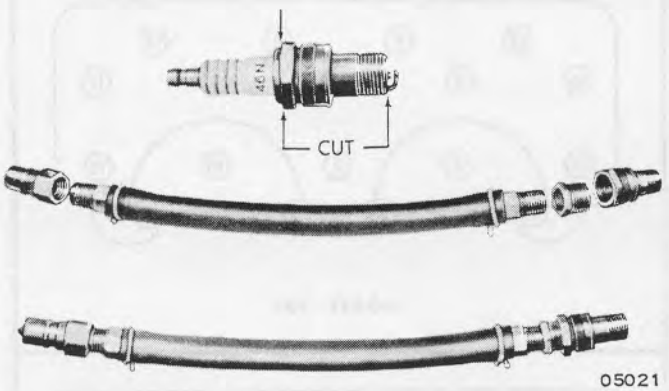

Figure 9. Air Adapter Tool

4. Compress valve spring with J-5892 tool to remove valve locks, valve cap (or rotator) and valve spring and damper. (Figure 10)
5. Remove valve stem oil seal.
6. Assemble as follows:

Models 283, 327, 350 and 409

a. Set valve spring and damper, valve shield and valve cap (or rotator) in place. Close-coiled end of spring is installed against cylinder head. Compress spring with J-5892 tool and install oil seal in lower groove of stem, making sure that seal is flat and not twisted.

NOTE: A light coat of oil on seal will help prevent twisting.

b. Install valve locks and release compressor tool, making sure that locks seat properly in upper groove of valve stem.

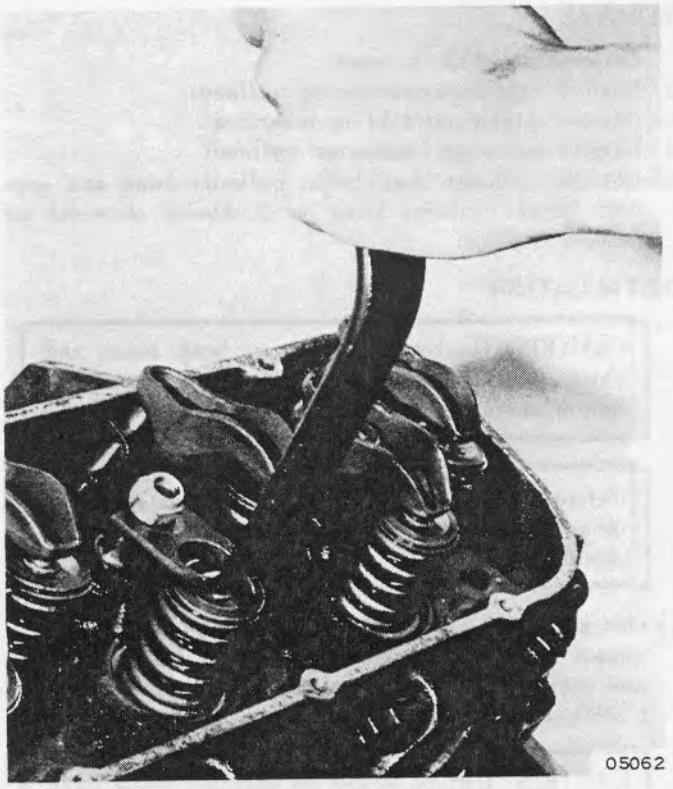

Figure 10. Compressing Valve Spring

NOTE: Grease may be used to hold locks in place while releasing compressor tool.

Models 427 and 482

a. Install new valve stem oil seal (coated with oil) in position over valve guide.
b. Set rotator (exhaust valve), valve spring and damper and valve cap in place.
c. Compress spring with J-5892 tool and install valve locks. Then release compressor tool, making sure that locks seat properly in groove of valve stem.

NOTE: Grease may be used to hold locks in place while releasing compressor tool.

7. Install spark plug, using a new gasket, and torque to specifications.
8. Install and adjust valve mechanism as outlined.

CYLINDER HEAD

REMOVAL

1. Drain cylinder block water.
2. Remove exhaust manifolds as outlined.
3. Remove intake manifold as described.
4. Remove valve mechanism as outlined.
5. Remove cylinder head bolts, cylinder head and gasket. Place cylinder head on 2 blocks of wood to prevent damage.

INSTALLATION

CAUTION: Gasket surfaces on both head and block must be clean of any foreign matter and free of nicks or deep scratches.

Cylinder bolt threads in block and threads on cylinder head bolts must be clean. (Dirt will affect bolt torque.)

1. On engines using a STEEL gasket, coat both sides of a new gasket with a good sealer. Spread sealer thin and even. A paint roller makes a good applicator. Too much sealer may hold gasket away from head or block.

CAUTION: Use no sealer on engines which have a box composition STEEL ASBESTOS gasket.

2. Place gasket in position over dowel pins with head up.
3. Carefully guide cylinder head into place over dowel pins and gasket.
4. Coat threads of cylinder head bolts with sealing compound and install bolts finger-tight.
5. Tighten each cylinder head bolt a little at a time in sequence shown in torque sequence chart until specified torque is reached. (Figure 11)
6. Install exhaust manifolds as outlined.
7. Install intake manifold as described.
8. Install and adjust valve mechanism as outlined.
9. Install valve covers.
10. Install distributor and adjust timing.

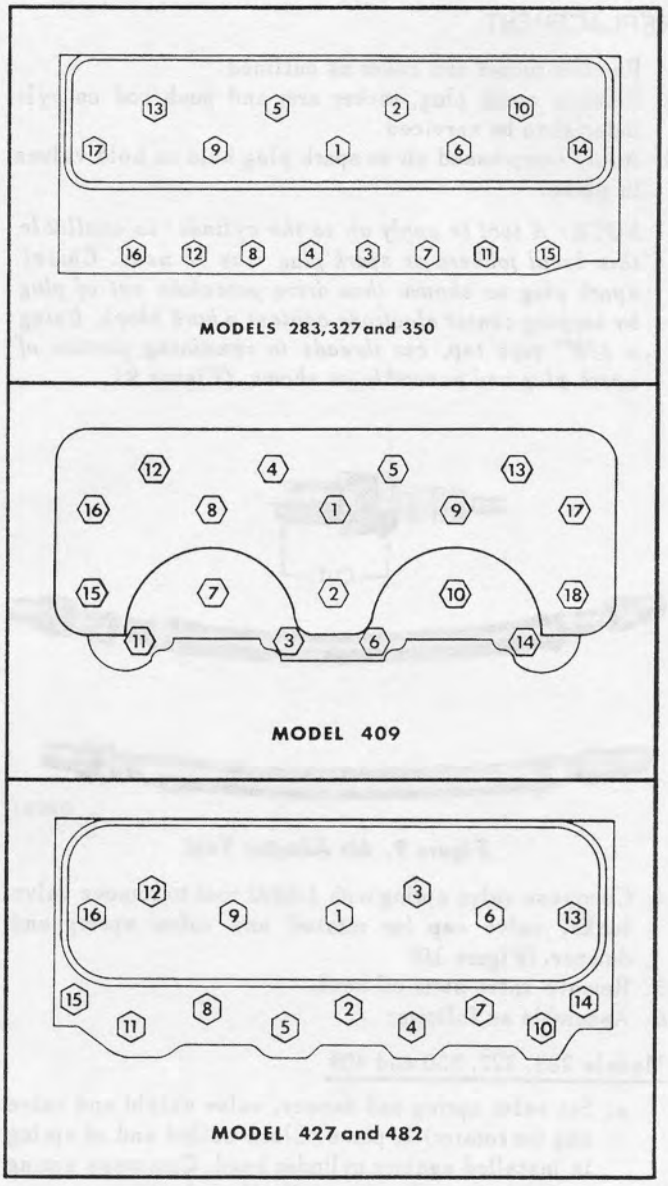

Figure 11. Cylinder Head Torque Sequence

CYLINDER HEAD and VALVE CONDITIONING

DISASSEMBLY

1. With cylinder head removed, remove valve rocker arm nuts, balls and rocker arms (if not previously done).
2. Compress valve springs with J-8062 tool (Figure 12) and remove valve retainers. Release compressor tool and remove spring caps, spring shields (if so equipped), springs and spring damper, then remove oil seals and valve spring shims.
3. Remove valves from cylinder head and place valves in a rack in their proper sequence for reassembly in their original positions.

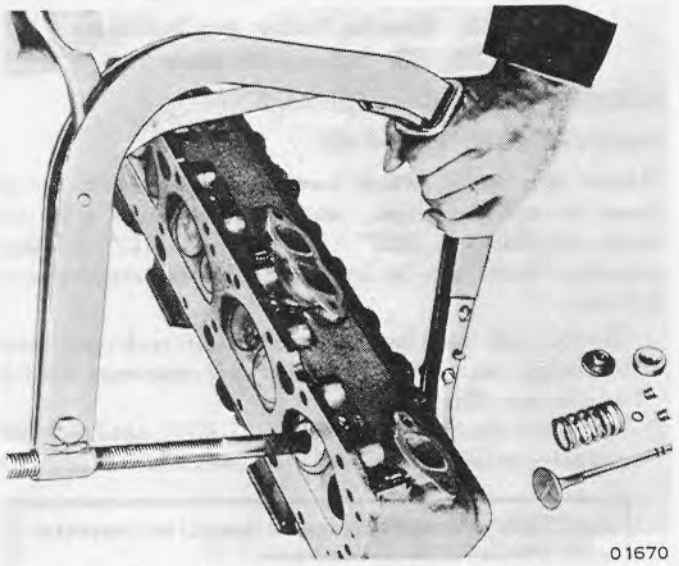

Figure 12. Compressing Valve Spring

CLEANING

1. Clean all carbon from combustion chambers and valve ports with J-8089 tool. (Figure 13)
2. Thoroughly clean valve guides with J-8101 tool. (Figure 14)
3. Clean all carbon and sludge from push rods, rocker arms and push rod guides.
4. Clean valve stems and heads on a buffing wheel.
5. Clean carbon deposits from head gasket mating surface.

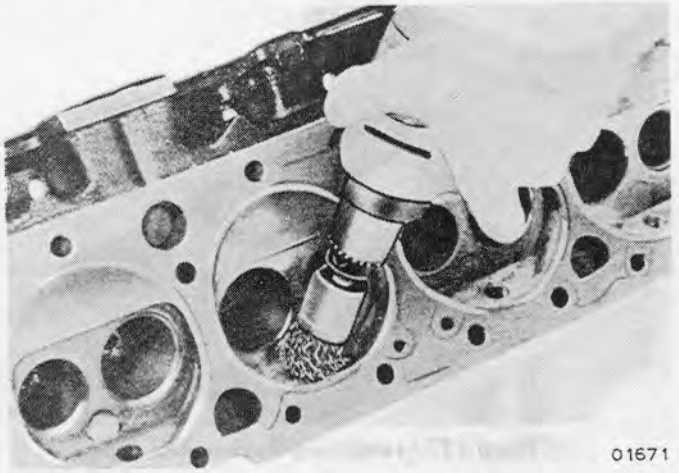

Figure 13. Cleaning Combustion Chambers

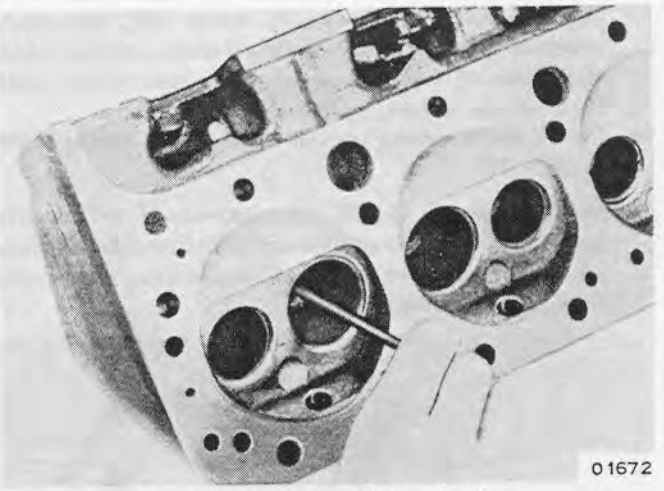

Figure 14. Cleaning Valve Guides

INSPECTION

1. Inspect cylinder head for cracks in exhaust ports, combustion chambers and for external cracks to water chamber.
2. Inspect valves for burned heads, cracked faces or damaged stems.

   NOTE: Excessive valve stem to bore clearance will cause excessive oil consumption and possible valve breakage. Insufficient clearance will result in noisy and sticky functioning of valve and disturb engine smoothness.

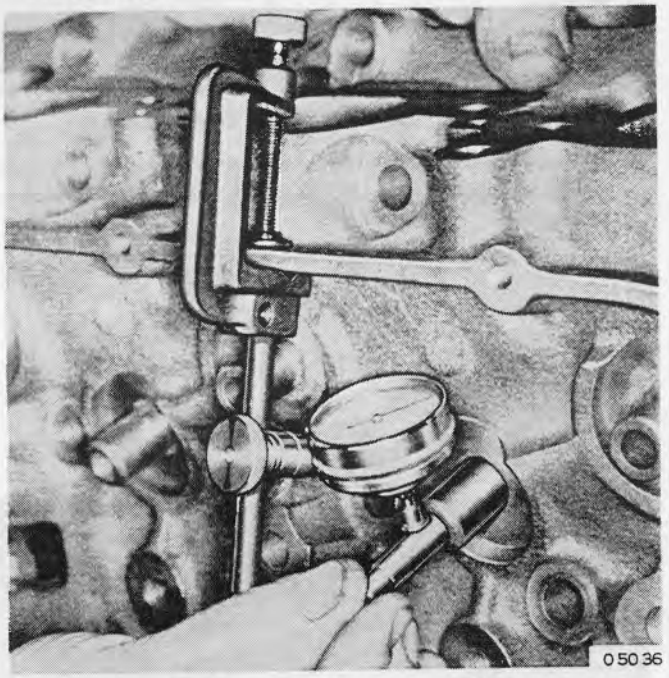

Figure 15. Measuring Valve Stem Clearance

3. Measure valve stem clearance (Figure 15) as follows: Clamp a dial indicator on one side of cylinder head rocker arm cover gasket rail, locating indicator so that movement of valve stem from side to side (cross-

wise to the head) will cause a direct movement of indicator stem. Indicator stem must contact side of valve stem just above valve guide. With valve head dropped about 1/16" (1.6mm) off valve seat, move valve stem from side-to-side, using light pressure to obtain a clearance reading. If clearance exceeds specifications, it will be necessary to ream valve guides for oversize valves, as outlined.

4. Check valve spring tension with J-8056 spring tester. (Figure 16)

NOTE: Springs should be compressed to specified height and checked against specification chart. Springs should be replaced if not within 10 lbs. of specified load (without dampers).

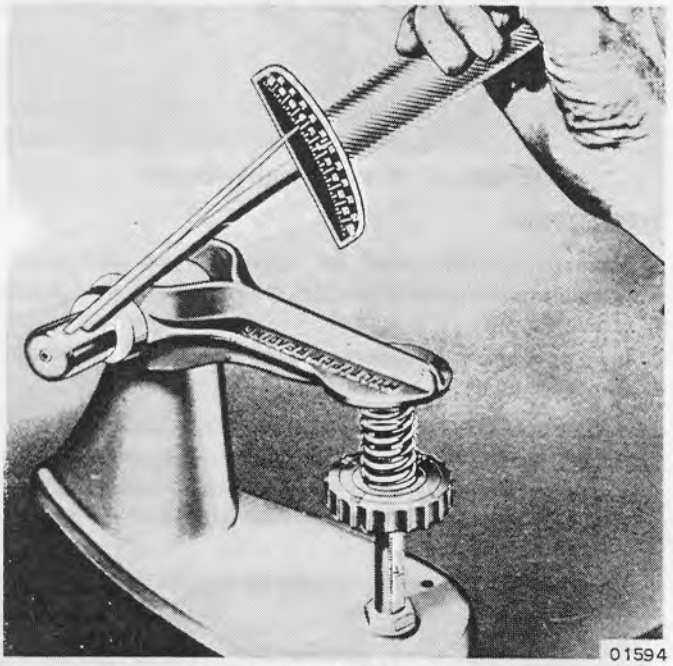

Figure 16. Checking Valve Spring Tension

5. Inspect rocker arm studs for wear or damage. Inspect push rod guides on 427 and 482 engines for wear or damage.

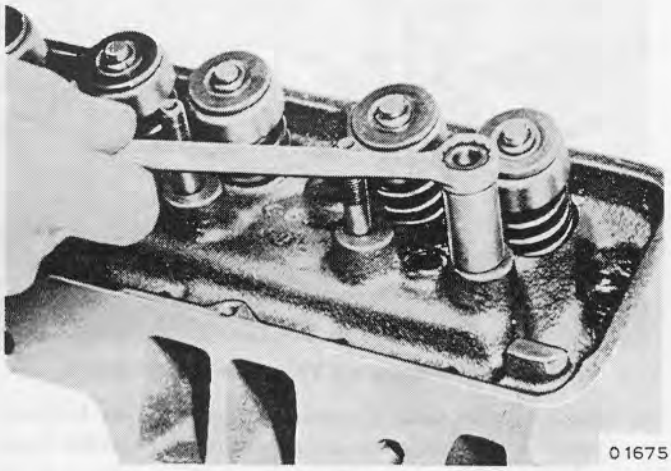

Figure 17. Removing Rocker Arm Stud - 283, 327, 350 and 409 Models

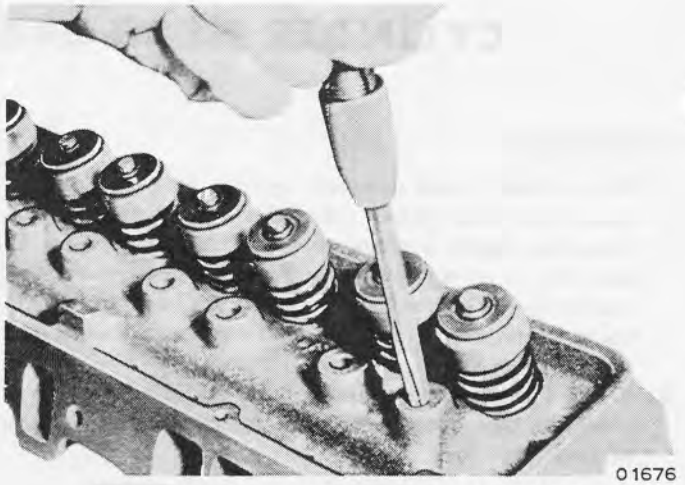

Figure 18. Reaming Rocker Arm Stud Bore - 283, 327, 350 and 409 Models

ROCKER ARM STUDS - REPAIRS

Models 283, 327, 350 and 409

Rocker arm studs, which have damaged threads or are loose in cylinder head, should be replaced with new studs available in .003" (.076mm) and .013" (.330mm) oversize. Studs may be installed after reaming holes as follows:

1. Remove old stud by placing J-5802-1 tool over stud, installing nut and flat washer and removing stud by turning nut. (Figure 17)
2. Ream hole for oversize stud with J-5715 tool for .003" oversize or J-6036 tool for .013" oversize. (Figure 18)

CAUTION: Do not attempt to install an oversize stud without reaming stud hole.

3. Coat press-fit area of stud with lubricant. Install new stud, using J-6880 tool as a guide. Gauge should bottom on head. (Figure 19)

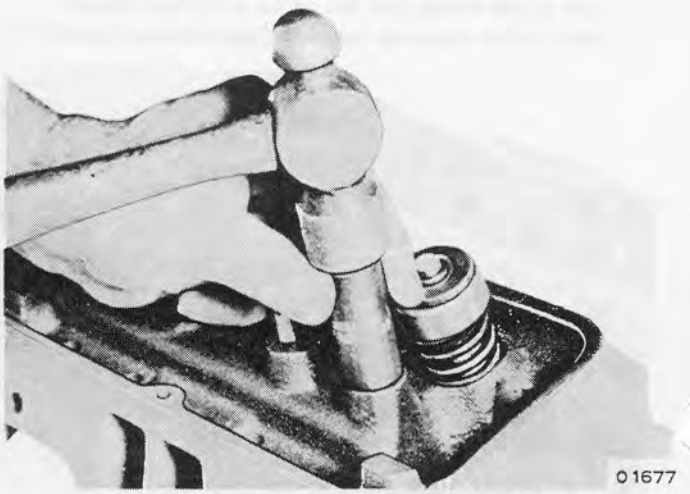

Figure 19. Installing Rocker Arm Stud - 283, 327, 350 and 409 Models

ROCKER ARM STUDS AND PUSH ROD GUIDES - REPAIRS

Models 427 and 482

Push rod guides are related to cylinder head by rocker arm studs. (Figure 20) Replace where necessary and torque rocker arm studs to specifications.

NOTE: Coat threads on cylinder head end of rocker arm studs with sealer before assembling to cylinder head.

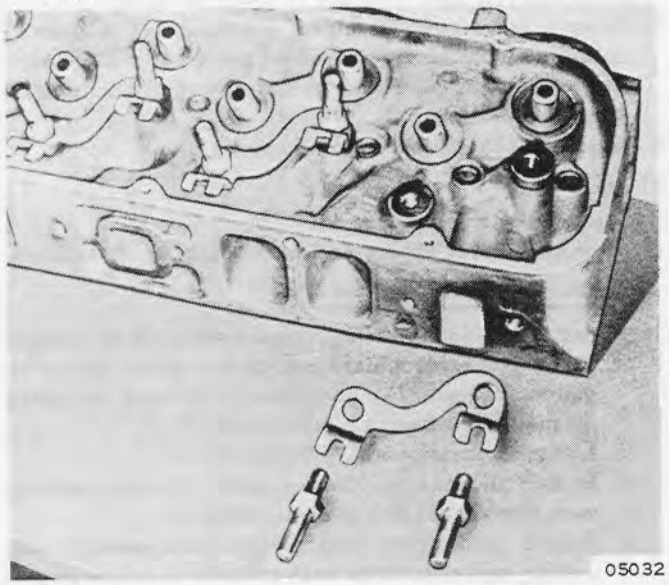

Figure 20. Rocker Arm Stud and Push Rod Guide

VALVE GUIDE BORES

Valves with oversize stems are available (see specifications). To ream valve guide bores for .015" (.381mm) oversize valves, use J-5830-2 tool for 283, 327 and 350 models or J-7910-5 tool for 409, 427 and 482 models. (Figure 21)

Figure 21. Reaming Valve Guide

VALVE SEATS

Valve seat reconditioning is very important, since seating of valves must be perfect for engine to deliver maximum power and performance.

Another important factor is valve head cooling. Good contact between each valve and its seat in head is important to insure that heat in valve head will be properly dissipated.

Several different types of equipment are available for reseating valve seats. Equipment manufacturer's recommendations should be followed carefully to attain proper results.

Regardless of type of equipment, however, it is essential that valve guide bores be free from carbon or dirt to insure proper centering of pilot in guide.

1. Install expanding pilot in valve guide bore and expand pilot.
2. Place roughing stone or forming stone over pilot and clean up valve seat only. Use a stone that is cut to specifications.
3. Remove roughing stone or forming stone from pilot, place finishing stone (cut to specifications) over pilot and cut just enough metal from seat to provide a smooth finish. Refer to "Specifications", Section 8 and Figure 23.
4. Narrow down valve seats to specified width by grinding port side with a 30° stone to lower seat and a 60° stone to raise seat.
5. Remove expanding pilot and clean cylinder head carefully to remove all chips and grindings from above operations.
6. Measure valve concentricity. (Figure 22)

NOTE: Valve seats should be concentric to within .002" (.051mm) total indicator reading.

Figure 22. Measuring Valve Seat Concentricity

VALVES

Pitted valves can be refaced to proper angle on a valve grinder, thus insuring correct relation between head and stem. Replace valve stems with excessive wear or valves which are warped excessively. When an excessively-warped valve head is refaced, a knife edge will be ground on part or all of the valve head, due to amount of metal that must be removed to completely reface. Knife edges lead to breakage, burning or pre-ignition caused by heat localizing in this knife edge. If edge of valve head is less than 1/32" (.8mm) thick after grinding, replace the valve.

Various equipment is available for refacing valves. Manufacturer's recommendations should be carefully followed to attain proper results.

1. If necessary, dress the valve refacing machine grinding wheel to make sure it is smooth and true. Set chuck at angle specified for valve. Refer to "Specifications" and Figure 23.

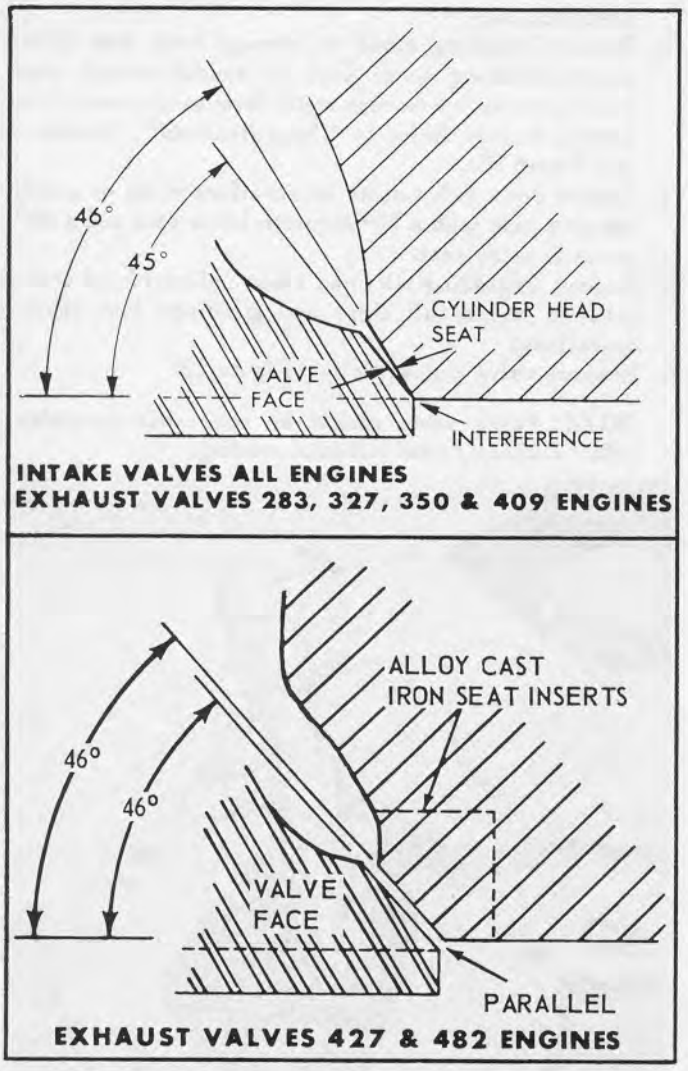

Figure 23. Relation of Valve and Seat Angles

2. Continue grinding until valve face is true and smooth all around the valve. If this makes valve head thin (1/32" [.8mm] minimum), valve must be replaced, or valve will overheat and burn.
3. Remove valve from chuck and place stem in "V" block. Feed valve squarely against grinding wheel to grind any pit from rocker arm end of stem.

   NOTE: Only extreme end of valve stem is hardened to resist wear. Do not grind end of stem excessively.
4. After cleaning valve face and cylinder head valve seat of grinding particles, make pencil marks about 1/4" (6.4mm) across the valve face, place valve in cylinder head and give valve 1/2-turn in each direction while exerting firm pressure on head of valve.
5. Remove valve and check face carefully. If all pencil marks have not been removed at point of contact with valve seat, repeat refacing operation and again recheck for proper seating.
6. Grind and check for remaining valves.

REASSEMBLY

1. Insert a valve in proper port.
2. Assemble valve spring and related parts as follows:

   Models 283, 327, 350 and 409

   a. Set valve spring shim, valve spring (with damper if used), valve shield and valve cap or rotator in place. (Figure 24) The close coiled end of spring is installed against cylinder head.
   b. Compress spring with J-8062 tool.
   c. Install oil seal in lower groove of stem, making sure that seal is flat and not twisted.
   d. Install valve locks and release compressor tool, making sure that locks seat properly in upper groove of valve stem.

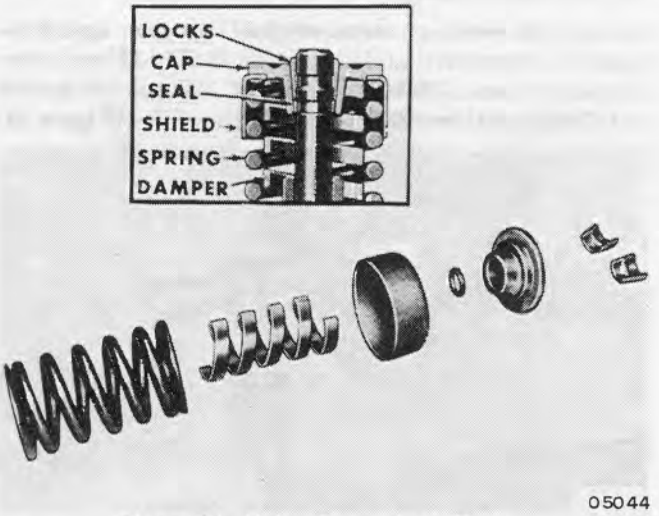

Figure 24. Valve Spring Installation - 283, 327, 350 and 409

Models 427 and 482

a. Install valve spring shim and/or exhaust valve rotator on valve spring seat, then install a new valve stem oil seal over valve and valve guide.

b. Set valve spring (with damper) and valve cap in place. (Figure 25)

c. Compress spring with tool J-8062.

d. Install valve locks and release compressor tool, making sure that locks seat properly in groove of valve stem.

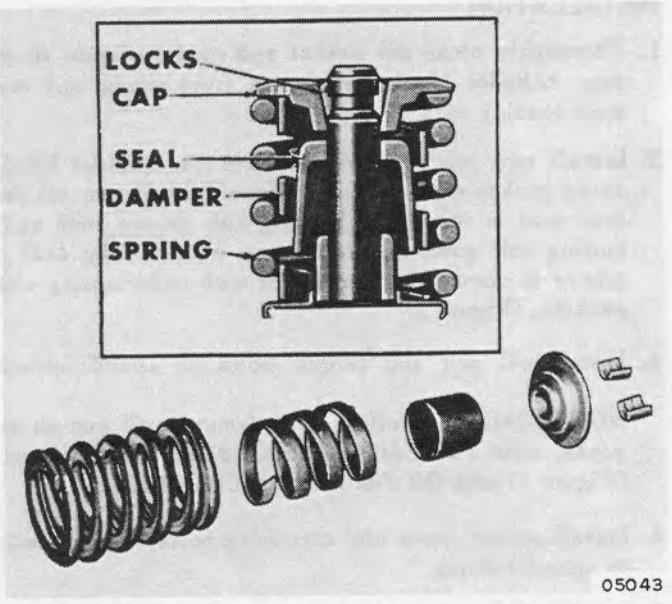

Figure 25. Valve Spring Installation - 427 and 482

NOTE: Grease may be used to hold locks in place while releasing compressor tool.

3. Install remaining valves.
4. On 283, 327, 350 and 409 engines, check each valve stem oil seal by placing a vacuum cup or similar device over end of valve stem and against cap. Operate vacuum cup and be sure that no air leaks past seal. A vacuum cup can be made from a small syringe and a high voltage shield. (Figure 26)
5. Check installed height of the valve springs with a narrow, thin scale. A cutaway scale will help. (Figure 27) Measure from top of shim or spring seat to top of valve spring or valve spring shield. (Figure 28) If this exceeds specified height, install a valve spring seat shim approximately 1/16" (1.6mm) thick. At no time should spring be shimmed to give an installed height under minimum specified.

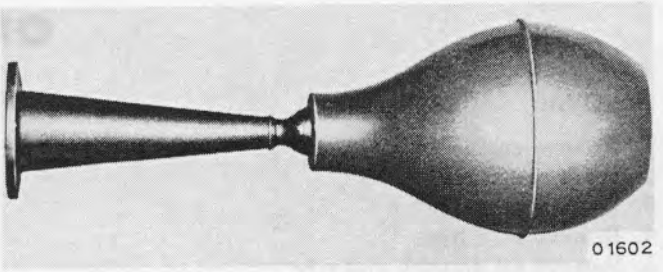

Figure 26. Vacuum Cup

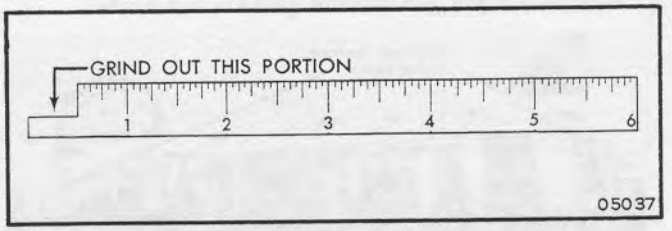

Figure 27. Cutaway Scale

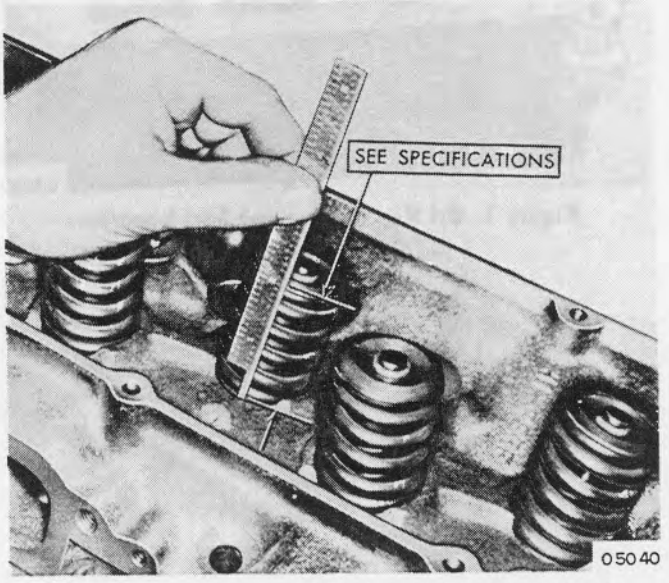

Figure 28. Measuring Valve Spring Installed Height

OIL PAN

REMOVAL

1. Remove engine from boat.
2. Drain crankcase oil.
3. Drain water.
4. Remove oil filter.
5. Remove oil dipstick and tube.
6. Remove starter.
7. Remove oil pan and discard gaskets and seals.

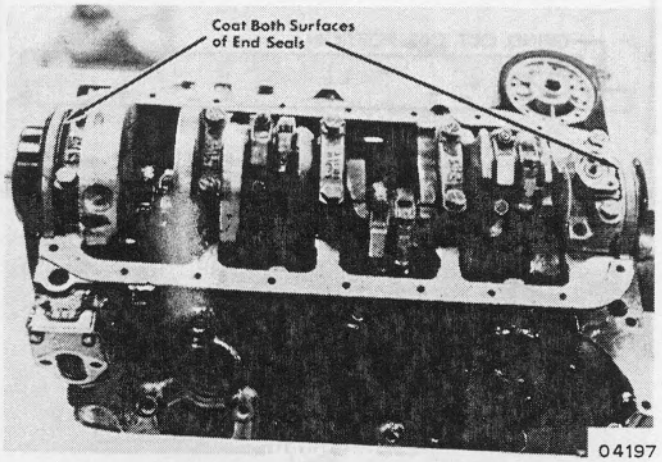

Figure 1. Oil Pan Gasket and Seal Locations

INSTALLATION

1. Thoroughly clean all gasket and seal surfaces on oil pan, cylinder block, crankcase front cover and rear main bearing cap.
2. Install new oil pan side gaskets on cylinder block, using gasket sealer as a retainer. Install new oil pan rear seal in rear main bearing cap groove with ends butting side gaskets. Install new oil pan front seal in groove in crankcase front cover with ends butting side gaskets. (Figure 1)
3. Install oil pan and torque bolts to specifications.

   NOTE: Before installing the aluminum oil pan on engines, coat surfaces of front and rear oil pan seals (Figure 1) with Oil Pan Sealant (C-92-52238-1).

4. Install starter brace and attaching bolts. Torque bolts to specifications.
5. Install oil dipstick tube and dipstick.
6. Install engine in boat. Fill engine with oil, start engine and check for leaks.

OIL PUMP

The oil pump consists of 2 gears and a pressure regulator valve enclosed in a 2-piece housing. Oil pump is driven by distributor shaft which is driven by a helical gear on camshaft.

A baffle is incorporated on pickup screen to eliminate pressure loss (427 & 482 engine oil pump tubes are bent at special angles).

REMOVAL

1. Remove oil pan as outlined.
2. Remove pump to rear main bearing cap bolt and remove pump and extension shaft.

DISASSEMBLY (Figures 2 and 3)

1. Remove pump cover attaching screws and pump cover.

   NOTE: Mark gear teeth for reassembly with same teeth indexing.

2. Remove idler gear, drive gear and shaft from pump body.
3. Remove pressure regulator valve retaining pin pressure regulator valve and related parts.
4. If pickup screen and pipe assembly need replacing, mount pump in a soft-jawed vise and extract pipe from pump.

CAUTION: Do not disturb pickup screen on pipe. This is serviced as an assembly.

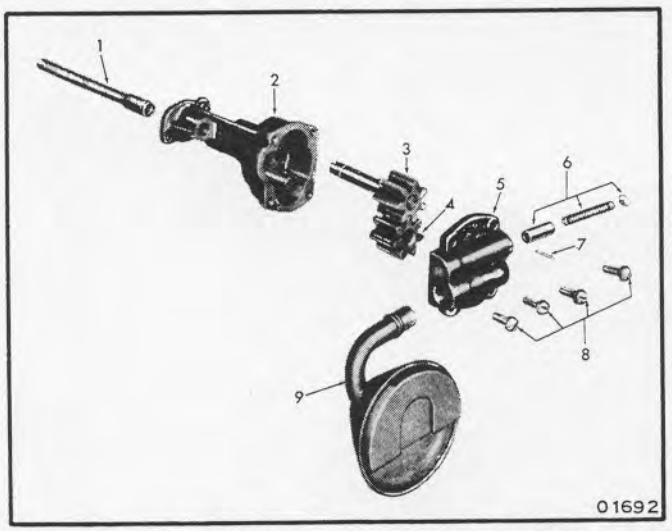

Figure 2. Oil Pump - 283, 327, 350 and 409

1 - Shaft Extension
2 - Pump Body
3 - Drive Gear and Shaft
4 - Idler Gear
5 - Pump Cover
6 - Pressure Regulator Valve
7 - Pressure Regulator Spring
8 - Retaining Pin
9 - Screws
10 - Pickup Screen and Pipe

CLEANING and INSPECTION

1. Wash all parts in cleaning solvent and dry with compressed air.
2. Inspect pump body and cover for cracks or excessive wear.
3. Inspect pump gears for damage or excessive wear.

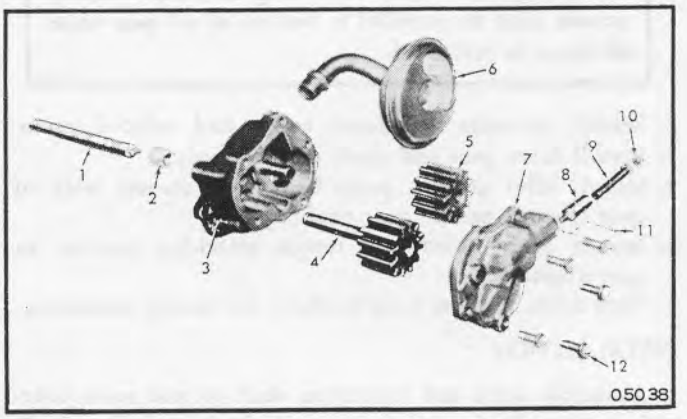

Figure 3. Oil Pump - 427 and 482

1 - Shaft Extension
2 - Shaft Coupling
3 - Pump Body
4 - Drive Gear and Shaft
5 - Idler Gear
6 - Pickup Screen and Pipe
7 - Pump Cover
8 - Pressure Regulator Valve
9 - Pressure Regulator Spring
10 - Washer
11 - Retaining Pin
12 - Screws

4. Check for loose drive gear shaft in pump body.
5. Inspect inside of pump cover for wear that would permit oil to leak past ends of gears.
6. Inspect pickup screen and pipe assembly for damage to screen, pipe or relief grommet.
7. Check pressure regulator valve for fit.

   NOTE: Pump gears and body are not serviced separately. If pump gears or body are damaged or worn, replacement of entire oil pump assembly is necessary.

REASSEMBLY

1. If pickup screen and pipe assembly was removed on 283, 327, 350 or 409 engines, it should be replaced with a new part. Loss of press-fit condition could result in an air leak and loss of oil pressure. Mount pump in a soft-jawed vise, apply sealer to end of pipe and, using tool J-8369, tap pipe in place with a plastic hammer. (Figure 4) The 427 and 482 pickup screen cannot be replaced.

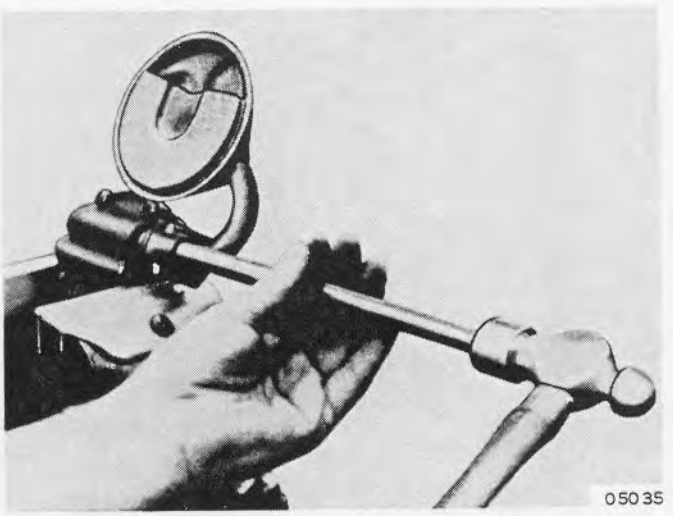

Figure 4. Installing Screen - 283, 327, 350 and 409

CAUTION: Be careful of twisting, shearing or collapsing pipe while installing in pump. Pickup screen must be parallel to bottom of oil pan when oil pump is installed.

2. Install pressure regulator valve and related parts.
3. Install drive gear and shaft in pump body.
4. Install idler gear in pump body with smooth side of gear toward pump cover opening.
5. Install pump cover and torque attaching screws to specifications.
6. Turn drive shaft by hand to check for smooth operation.

INSTALLATION

1. Assemble pump and extension shaft to rear main bearing cap, aligning slot on top end of extension shaft with drive tang on lower end of distributor drive shaft.
2. Install pump to rear bearing cap bolt and torque to specifications. (Figure 5)

   NOTE: Oil pump screen is installed with bottom edge parallel to oil pan rails.

3. Install oil pan as outlined.

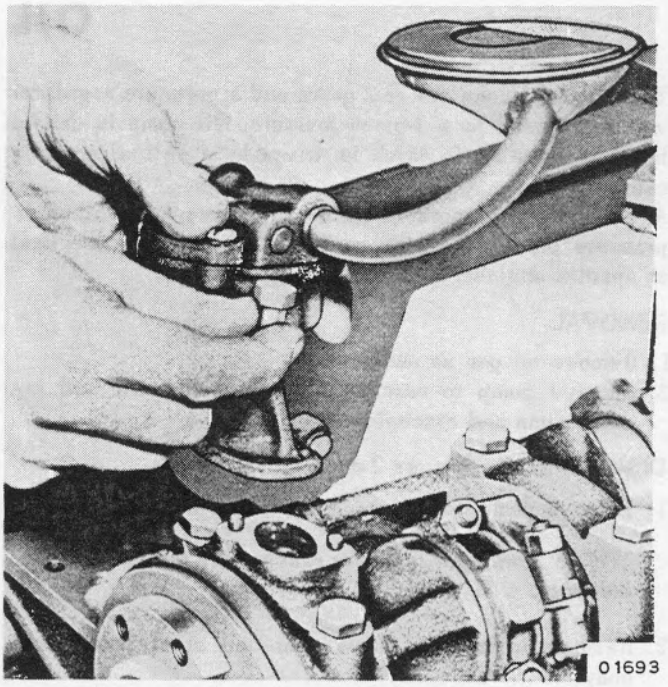

Figure 5. Oil Pump Removal and Installation

TORSIONAL DAMPER

REMOVAL

1. Remove drive belts and water pump pulley.
2. Remove accessory drive pulley, then (if so equipped), remove damper retaining bolt.
3. Install tool J-6978 on damper and, turning puller screw, remove damper. (Figure 6)

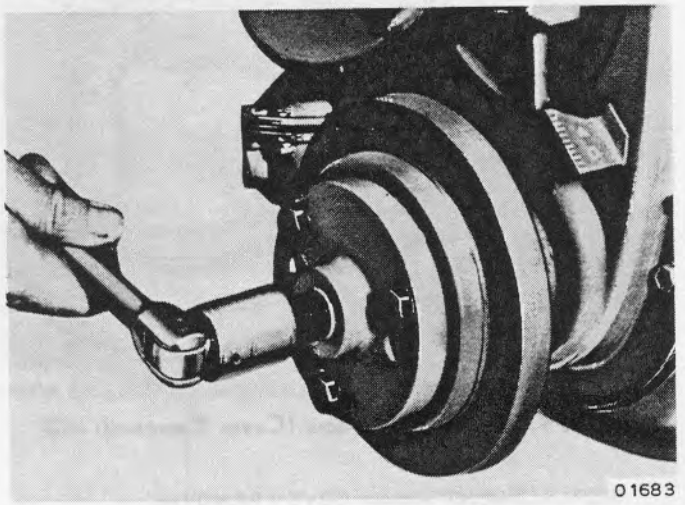

Figure 6. Removing Torsional Damper

NOTE: Tool J-6978 contains holes forming 2 patterns, a 2-bolt and a 3-bolt pattern. Holes for the 2-bolt pattern must be elongated for 427 and 482 engines.

INSTALLATION

CAUTION: Inertia weight section of torsional damper is assembled to hub with rubber-type material. Installation procedures must be followed, or movement of inertia weight section on hub will destroy tuning of torsional damper. DO NOT drive damper on.

1. Coat front cover seal contact area (on damper) with engine oil.
2. Install damper on crankshaft as follows:
   a. Place damper in position over key on crankshaft.
   b. Pull torsional damper onto crankshaft.
      Models 283, 327 and 350 - Install damper with a thick flat washer, a full-threaded 7/16-20x5" bolt and nut.
      Models 427 and 482 - Use tool J-21058. If not available, pull damper on with a thick flat washer, a full-threaded ½-20x5" bolt and a ½-20 nut.

      CAUTION: Install bolt in crankshaft with sufficient thread engagement (minimum ½" [12.7mm]).

   c. Remove bolt or tool from crankshaft, then install damper retaining tool and torque to specifications.
3. Install accessory drive pulley.
4. Install water pump pulley and drive belts.

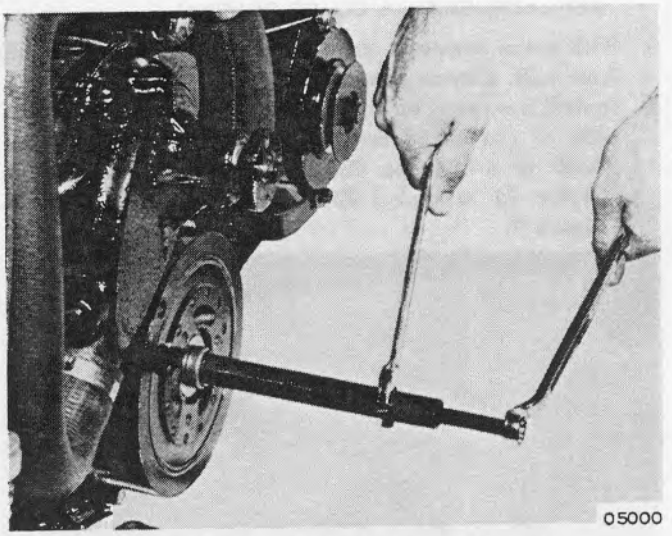

Figure 7. Installing Torsional Damper

CRANKCASE FRONT COVER

REMOVAL

1. Remove oil pan as outlined.
2. Remove torsional damper as instructed.
3. Remove water pump.
4. Remove crankcase front cover attaching screw, remove front cover and gasket, then discard gasket.

INSTALLATION

1. Make certain that cover mounting face and cylinder block front end face are clean and flat.
2. Coat oil seal with engine oil and, using a new cover gasket, coated with gasket sealer, install cover and gasket cover dowel pins and cylinder block.
3. Install cover screws and torque to specifications.
4. Install water pump.
5. Install torsional damper as described.
6. Install oil pan as outlined.

OIL SEAL

REPLACEMENT with COVER REMOVAL

1. With cover removed, pry old seal out of cover from the front with a large screwdriver.
2. Install new seal so that open end of seal is toward inside of cover and drive it into position with tool J-23042 or J-8340 on 283, 327, 350 and 409 models. (Figure 8) or tool J-22102 on 427 and 482 models. (Figure 9)

01685

Figure 8. Installing Oil Seal (Cover Removed) - 283, 327, 350 and 409

NOTE: Some left handed engines have helical grooves in seal.

CAUTION: Support cover at seal area. (Tool J-971 may be used as support.)

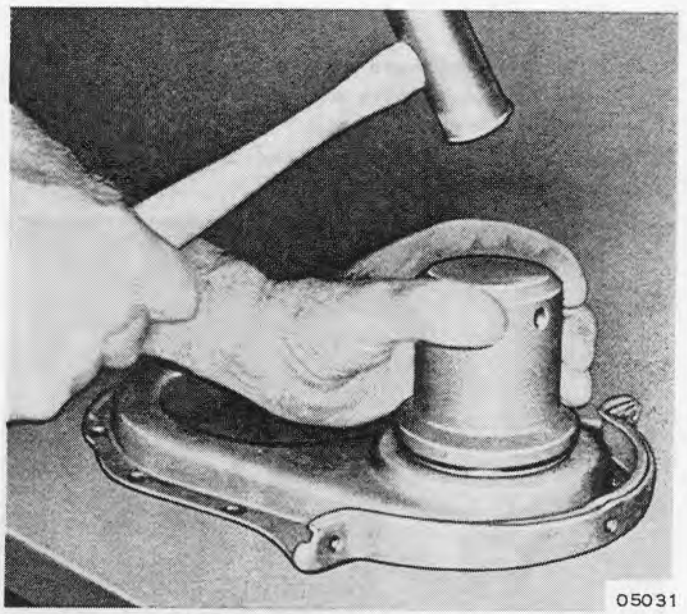

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Figure 9. Installing Oil Seal (Cover Removed) -427 and 482

REPLACEMENT without COVER REMOVAL

1. With torsional damper removed, pry seal out of cover from the front with a large screwdriver, being careful not to damage surface on crankshaft.
2. Install new seal so that open end of seal is toward inside of cover and drive it into position with tool J-8340 or J-23042 on 283, 327, 350 and 409 models (Figure 10) or tool J-22102 on 427 and 482 models. (Figure 11)

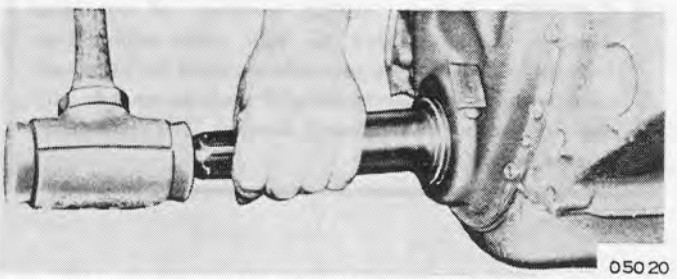

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Figure 10. Installing Oil Seal (Cover Installed) - 283, 327, 350 and 409

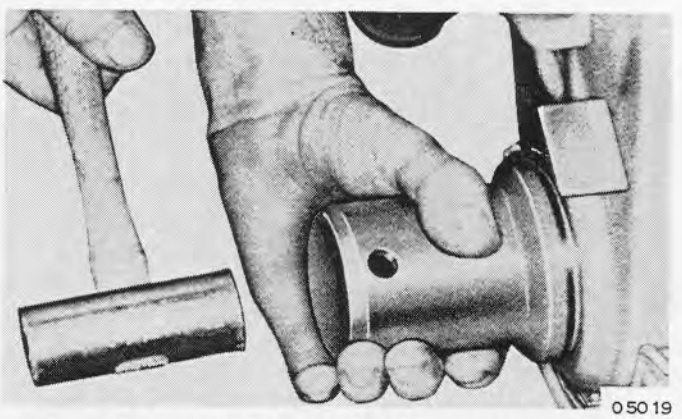

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Figure 11. Installing Oil Seal (Cover Installed) - 427 and 482

FLYWHEEL

REMOVAL

1. Remove engine from boat.
2. Remove transmission, if so equipped.
3. Remove flywheel housing and coupler or drive plate.

INSPECTION

1. Inspect coupler or drive plate for wear.
2. Check flywheel ring gear for worn or missing teeth.

INSTALLATION

1. Clean mating surfaces of flywheel and crankshaft.
2. Install flywheel on crankshaft and align dowel hole of crankshaft flange and flywheel. (Figure 12)
3. Install coupler or drive plate.
4. Check flywheel runout by mounting dial indicator on machined surface of flywheel.
5. Runout should not exceed .008"(.203mm). If excessive, remove flywheel and check for burrs or replace flywheel.
6. Replace bell housing.
7. Install transmission, if so equipped.
8. Install engine in boat.

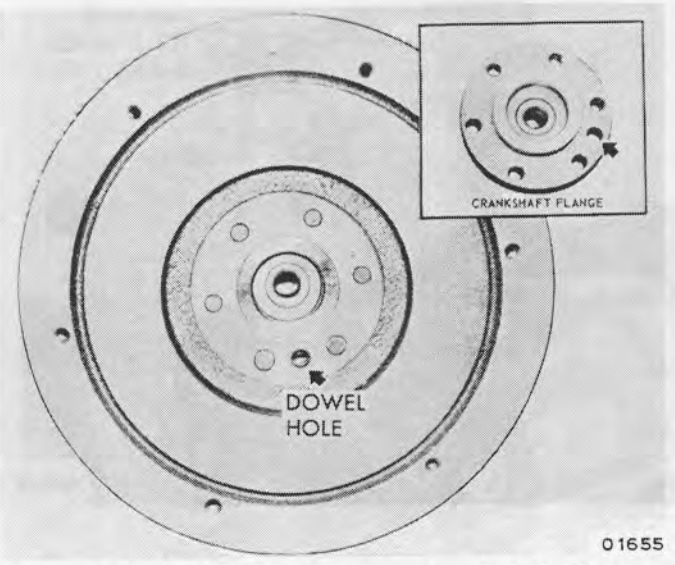


Figure 12. Flywheel Positioned on Crankshaft Flange

ENGINE COUPLING

INSPECTION

Engine coupling failure may result from the following:

1. Failure of engine coupling assembly spline and/or universal splined shaft indicates lack of sufficient lubrication at time of installation. On initial installation, and whenever a stern drive unit is removed, be sure to lubricate engine coupling splines with New Multipurpose Lubricant (C-92-49588). Spline mating surfaces will wear very rapdily if installed dry.
2. Hub bond, which shears or pull loose from hub center, indicates engine drive mis-alignment. Engine should be aligned with correct alignment tool.

OIL SEAL (REAR MAIN)

REPLACEMENT

Rear main bearing oil seal can be replaced (both halves) without removing crankshaft.

NOTE: Always replace upper and lower seal as a unit. Install with lip facing toward front of engine.

1. Remove oil pan and oil pump.
2. Remove rear main bearing cap.
3. Remove oil seal from annular tang by prying from bottom with a small screwdriver.
4. Lubricate lip of a new seal with engine oil. Keep oil off parting line surface, as this is treated with glue. Insert seal in cap and roll it into place with finger and thumb, using light pressure so that seal tangs at parting line do not cut bead on back of seal.
5. To remove upper half of seal, use a small hammer to tap a brass pin punch on one end of seal until it protrudes far enough to be removed with pliers. (Figure 13)

NOTE: Always wipe crankshaft surface clean before installing a new seal.

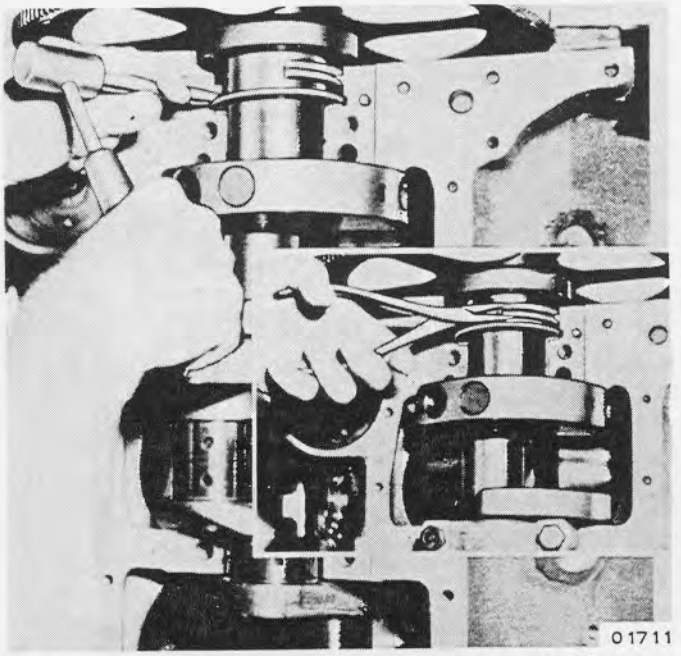
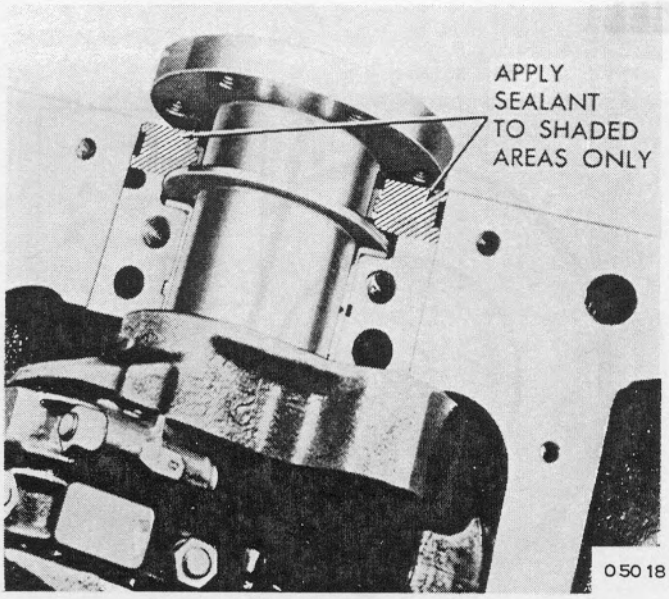


Figure 13. Removing Oil Seal (Upper Half)



6. Lubricate lip of a new seal with engine oil. Keep oil off parting line surface. Gradually push with a hammer handle, while turning crankshaft, until seal is rolled into place (similar to installing a main bearing). Be careful that seal tangs at parting line do not cut bead on back of seal.
7. Apply sealer to cylinder block in seal area. (Figure 14)
8. Install rear main bearing cap (with new seal) and torque to specifications.
9. Install oil pump and oil pan as outlined.

Figure 14. Sealing Bearing Cap and Block

MAIN BEARINGS

Main bearings are precision insert type and do not utilize shim for adjustment. If clearances are excessive, a new bearing (both upper and lower halves) will be required. Bearings are available in standard size and .001", .002", .009", .010", .020" and .030" undersize. (.001"=.025mm) Selective fitting of both rod and main bearing inserts is necessary in production to obtain close tolerances. Consequently, one half of a standard insert may have one half of a .001" undersize insert which will decrease clearance .0005" from using a full standard bearing.

When a production crankshaft cannot be precision fitted by this method, it then is ground .009" undersize on main journals only. A .009" undersize bearing and .010" undersize bearing may be used for precision fitting in the same manner as previously described. Any engine fitted with a .009" undersize crankshaft will be identified by the following markings:

- ".009" will be stamped on crankshaft counterweight forward of center main journal.
- A figure "9" will be stamped on block at left front oil pan rail.

NOTE: If, for any reason, main bearing caps are replaced, shimming may be necessary. Laminated shims for each cap are available for service. Shim requirement will be determined by bearing clearance.

INSPECTION

In general (except No. 2 bearing), lower half of bearing shows a greater wear and most distress from fatigue. After inspection, if lower half is suitable for use, it can be assumed that the upper half also is satisfactory. If lower half is worn or damaged, both upper and lower halves should be replaced. Never replace one half without replacing the other. Typical bearing failures are shown in Figure 1A.

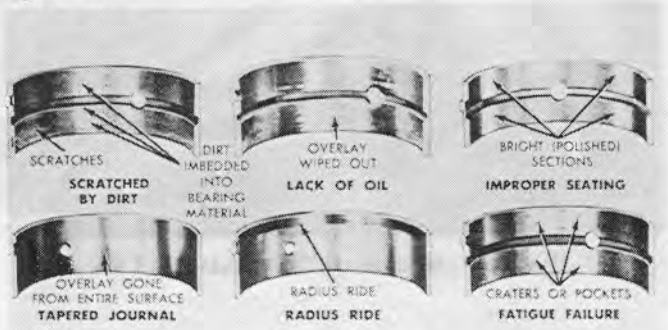


Figure 1A. Typical Bearing Failure

CHECKING CLEARANCE

To obtain best results, use Plastigage (or its equivalent), a wax-like plastic material which will compress evenly between bearing and journal surfaces without damaging either surface.

With engine upside down, crankshaft will rest on upper bearings, and total clearance can be measured between lower bearing and journal.

NOTE: To assure proper seating of crankshaft, all bearing cap bolts should be at their specified torque. In addition, surface of crankshaft journal and bearing should be wiped clean of oil before checking fit of bearings.

1. With oil pan and oil pump removed (starting with rear main bearing), remove bearing cap and wipe oil from journal and bearing cap.
2. Place a piece of gauging plastic full width of bearing (parallel to crankshaft) on journal. (Figure 1)

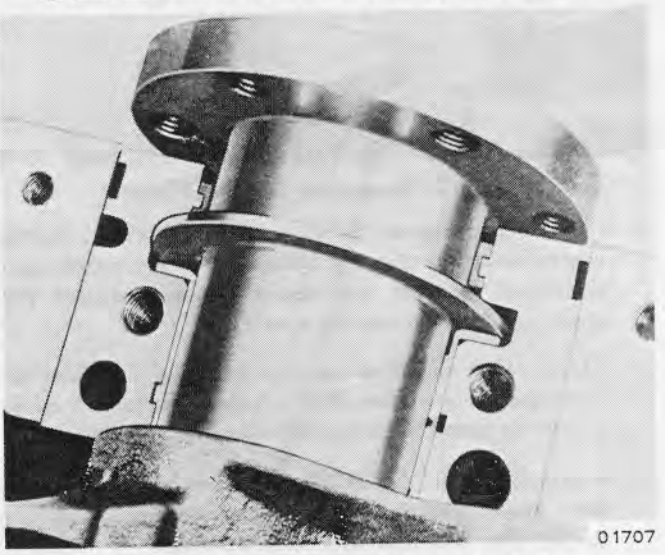


Figure 1. Gauging Plastic on Journal

CAUTION: Do not rotate crankshaft while gauging plastic is between bearing and journal.

NOTE: Remove oil seal from rear main bearing cap prior to checking clearance.

3. Install bearing cap and torque retaining bolts evenly to specifications.
4. Remove bearing cap. Flattened gauging plastic will be found adhering to either bearing shell or journal.
5. Use graduated scale (correlated in thousandths of an inch) on edge of gauging plastic envelope. Without removing gauging plastic, measure its compressed width (at widest point) with graduations on gauging plastic envelope. (Figure 2)

NOTE: Main bearing journals usually wear evenly and are not out-of-round. However, if a bearing is being fitted to an out-of-round journal (.001" □.025mm□ maximum), be sure to fit to maximum diameter of journal. If bearing is fitted to minimum diameter, and journal is out-of-round .001", interference between bearing and journal will result in rapid bearing failure. If flattened gauging plastic tapers toward middle or ends, there is a difference in clearance indicating taper, low spot or other irregularity of bearing or journal. Be sure to measure journal with a micrometer if flattened gauging plastic indicates more than .001" difference.

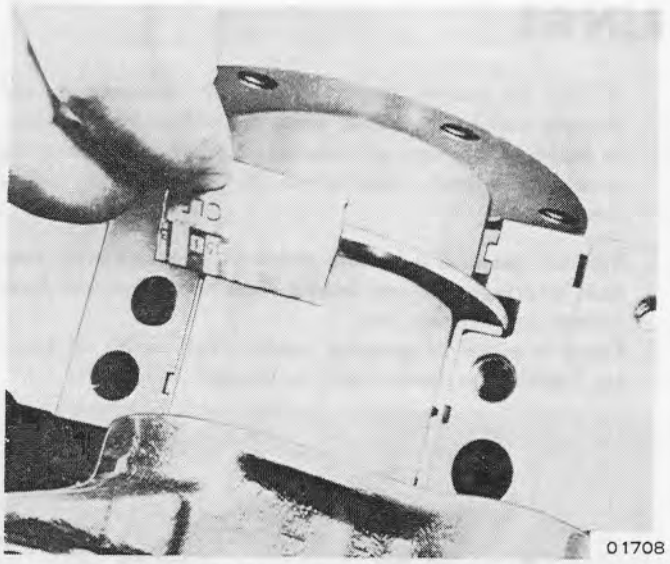


Figure 2. Measuring Gauging Plastic

6. If bearing clearance is within specifications, bearing insert is satisfactory. If clearance is not within specifications, replace the insert. Always replace both upper and lower insert as a unit.

   NOTE: If a new bearing cap is being installed and clearance is less than .001", inspect for burrs or nicks. If none is found, then install shims as required.

7. A standard .001" or .002" undersize bearing may produce proper clearance. If not, regrind crankshaft journal for use with next undersize bearing.
8. Proceed to next bearing. After all bearings have been checked, rotate crankshaft to see that excessive drag does not exist.
9. Measure crankshaft end play (see specifications) by forcing crankshaft to extreme front position. Measure at front end of rear main bearing with a feeler gauge. (Figure 3)
10. Install a new rear main bearing oil seal in cylinder block and main bearing cap.

REPLACEMENT

NOTE: Main bearings may be replaced with or without removing crankshaft.

WITH CRANKSHAFT REMOVAL

1. Remove and inspect crankshaft.
2. Remove main bearings from cylinder block and main bearing caps.
3. Coat bearing surfaces of new, correct size, main bearings with oil and install in cylinder block and main bearing caps.
4. Install crankshaft.

WITHOUT CRANKSHAFT REMOVAL

1. With oil pan, oil pump and spark plugs removed, remove cap on main bearing requiring replacement and remove bearing from cap.
2. Replace main bearing upper half as follows:
   a. Install main bearing removing and installing tool in crankshaft journal oil hole.

      NOTE: If tool is not available, bend a cotter pin.

   b. Rotate crankshaft clockwise (as viewed from front of engine). This will roll upper bearing out of block.
   c. Oil new selected size upper bearing and insert plain (unnotched) end between crankshaft and indented or notched side of block. Rotate bearing into place and remove tool from oil hole in crankshaft journal.
3. Oil new lower bearing and install in bearing cap.
4. Install main bearing cap with arrows pointing toward front of engine.
5. Torque main bearing cap bolts to specifications.

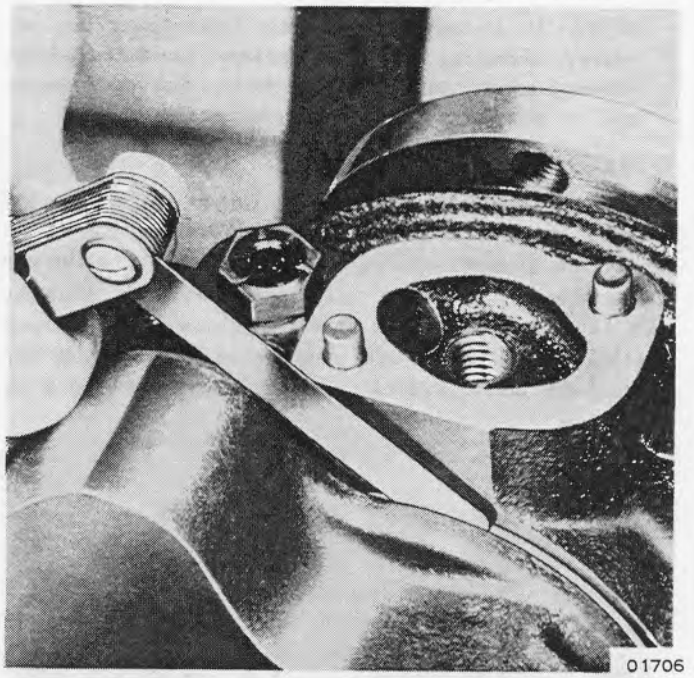


Figure 3. Measuring Crankshaft End Play

CONNECTING ROD BEARINGS

Connecting rod bearings are precision insert type and do not utilize shims for adjustment. DO NOT FILE RODS OR ROD CAPS. If clearances are found to be excessive, a new bearing will be required. Bearings are available in standard size and .001" and .002" undersize for new and used standard size crankshafts and in 010" and .020" undersize for reconditioned crankshafts. (.001"=.025mm)

INSPECTION and REPLACEMENT

1. With oil pan and oil pump removed, remove connecting rod cap and bearing.
2. Inspect bearing for wear or damage and replace unsatisfactory bearings. Typical bearing failures are shown in Figure 1A.
3. Wipe bearings and crankpin clean of oil.
4. Measure crankpin for out-of-round or taper with a micrometer. If not within specifications, replace or recondition crankshaft. If within specifications, and a new bearing is to be installed, measure maximum diameter of crankpin to determine new bearing size required.
5. If within specifications, measure new or used bearing clearances with Plastigage or its equivalent.

   NOTE: If a bearing is being fitted to an out-of-round crankpin, be sure to fit to maximum diameter of crankpin. If bearing is fitted to minimum diameter, and crankpin is out-of-round .001", interference between bearing and crankpin will result in rapid bearing failure.

   a. Place a piece of gauging plastic the full width of crankpin (parallel to crankshaft). (Figure 4)
   b. Install bearing in connecting rod and cap.
   c. Install bearing cap and torque nuts evenly to specifications.

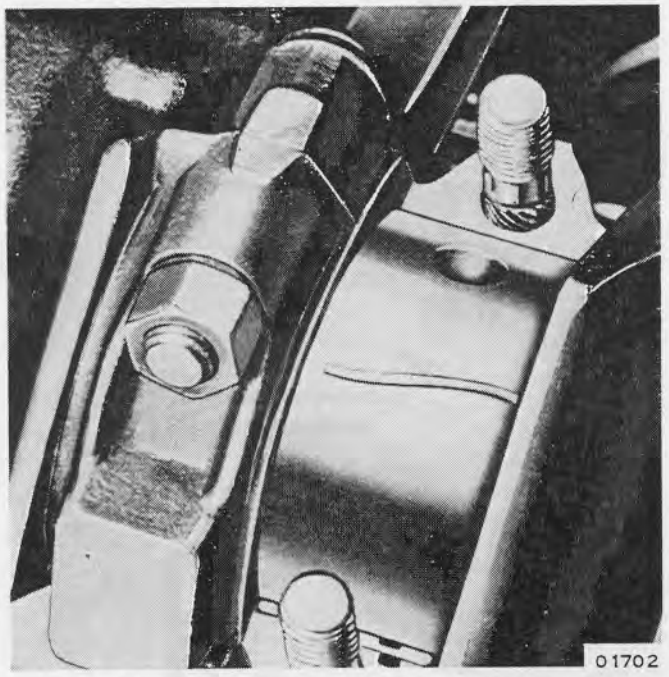


Figure 4. Gauging Plastic on Crankpin

CAUTION: Do not turn crankshaft with gauging plastic installed.

   d. Remove bearing cap and, using scale on gauging plastic envelope, measure gauging plastic width at the widest point. (Figure 5)

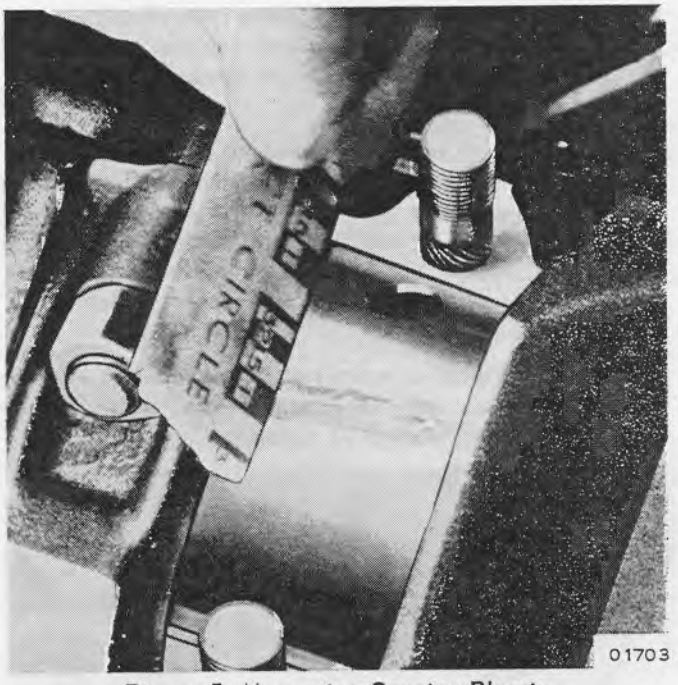


Figure 5. Measuring Gauging Plastic

6. If clearance exceeds specifications, select a new, correct size bearing and remeasure clearance.
7. Coat bearing surface with oil, install rod cap and torque nuts to specifications.
8. When all connecting rod bearings have been installed, tap each rod lightly (parallel to crankpin) to make sure they have clearance.
9. Measure all connecting rod side clearances (see specifications) between connecting rod caps. (Figure 6)

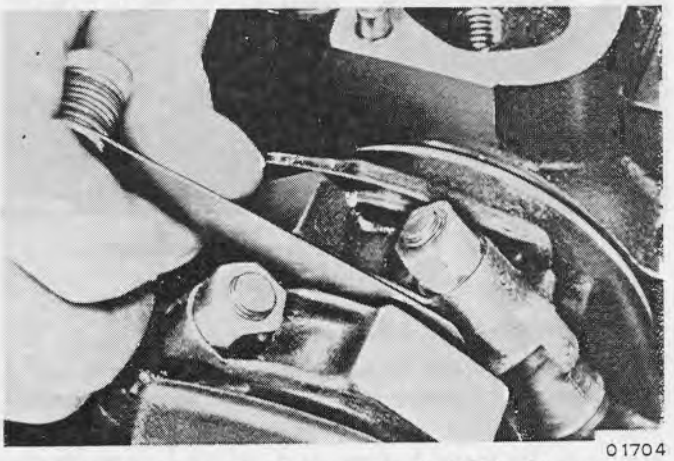


Figure 6. Measuring Connecting Rod Side Clearance

CONNECTING ROD and PISTON ASSEMBLIES

REMOVAL

1. With oil pan, oil pump and cylinder head removed, use a ridge reamer to remove any ridge and/or deposits from upper end of cylinder bore.

   NOTE: Before ridge and/or deposits are removed, turn crankshaft until piston is at bottom of stroke and place a cloth on top of piston to collect cuttings. After ridge and/or deposits are removed, turn crankshaft until piston is at top of stroke, then remove cloth and cuttings.

2. Mark connecting rod and bearing caps left bank 1, 3, 5 and 7; right bank 2, 4, 6 and 8 from front to rear on same side as piston thrust.
3. Remove connecting rod cap and install tool J-5239 (3/8") or J-6305 (11/32") on studs. Push connecting rod and piston assembly out of top of cylinder block. (Figure 7)

   NOTE: It will be necessary to turn crankshaft slightly to disconnect some connecting rod and piston assemblies and push them out of cylinder.

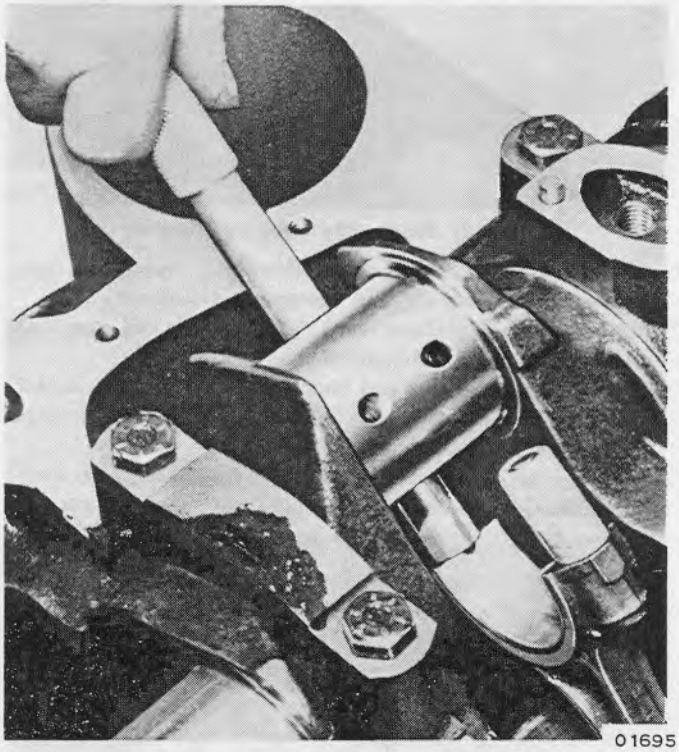


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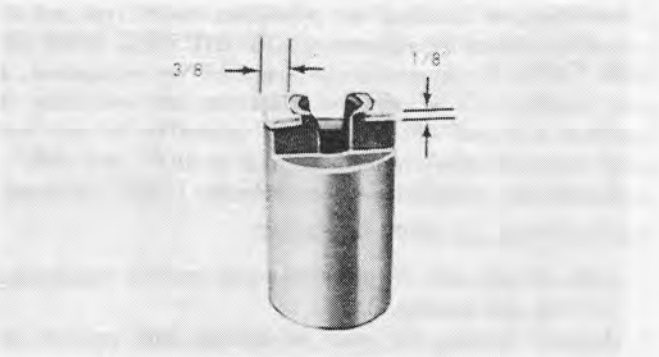
Figure 7. Removing Piston Assemblies

DISASSEMBLY

PISTON SUPPORT TOOL

If bosses on pistons do not allow piston support tool J-9510-1 to seat squarely on piston for press operations, tool modifications are necessary. To allow adequate clearance for these bosses, turn or grind upper portion of tool to dimensions shown in Figure 8. Tool modification, as described, does not affect tool application on other pistons.



3/8"=9.5mm *1/8"=3.2mm*

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Figure 8. Piston Support Tool Rework

1. Remove connecting rod bearings from connecting rods and caps.

   NOTE: If connecting rod bearings are being reused, place them in a rack to aid in reinstalling in their original rod and cap.

2. Remove piston rings with ring expander.
3. Place connecting rod and piston assembly in arbor press with piston on support. Press piston pin out of connecting rod and piston with piston pin tool (except model 482). Model 482 has floating piston pin which can be taken out by removing keeper rings. (Figure 9)

PISTON PIN TOOL	
Models 283, 327 and 350	- Tool J-9510 (Figure 9)
Models 409 and 427	- Tool J-6994 (Figure 10)

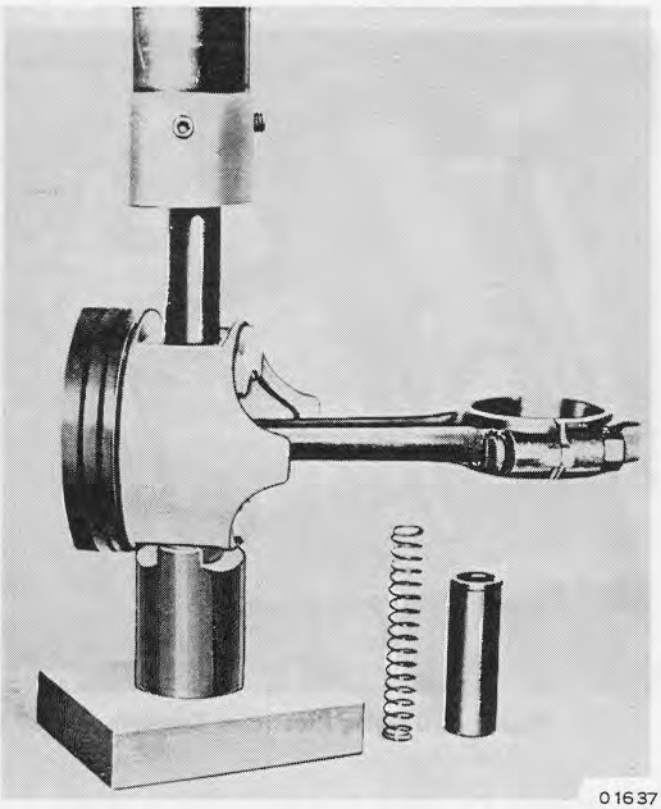

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Figure 9. Removing Piston - 283, 327 and 350

4. Remove assembly from arbor press and remove tools, piston pin, connecting rod and piston.

CLEANING AND INSPECTION

CONNECTING RODS

1. Wash connecting rods in cleaning solvent and dry with compressed air.
2. Check for twisted or bent rods and inspect for nicks or cracks. Replace damaged connecting rods.

PISTONS

1. Clean varnish from piston skirts and pins with a cleaning solvent. DO NOT WIRE BRUSH ANY PART OF PISTON. Clean ring grooves with a groove cleaner and make sure oil ring holes and slots are clean.
2. Inspect piston for cracked ring lands, skirts or pin bosses, wavy worn ring lands, scuffed or damaged skirts, eroded areas at top of piston. Replace pistons which are damaged or show signs of excessive wear.
3. Inspect grooves for nicks or burrs that might cause rings to hang up.
4. Measure piston skirt (across centerline of piston pin) and check clearance as outlined under "Piston Selection".

PISTON PINS

1. Piston pin clearance is designed to maintain adequate clearance under all engine operating conditions. Because of this, piston and piston pin are a matched set and not serviced separately.
2. Inspect piston pin bores and piston pins for wear. Piston pin bores and piston pins must be free of varnish or scuffing when measured. Measure piston pin with a micrometer and piston pin bore with a dial bore gauge or inside micrometer. If clearance is in excess of the .001" (.025 mm) wear limit, replace piston and piston pin assembly.

Figure 10. Removing Piston - 409 and 427

PISTON RINGS

All compression rings are marked on upper side of ring. When installing compression rings, make sure that marked side is toward top of piston. Top ring is chrome faced or treated with molybdenum for maximum life.

Oil control rings (except 427 and 482) are 3-piece type, consisting of 2 segments (rails) and a spacer. The 427 and 482 engines use a chrome plated cast iron ring and an expander.

1. Select rings comparable in size to piston being used.
2. Slip compression ring in cylinder bore, then press ring down into cylinder bore about 1/4" (6.35mm) (above ring travel). Be sure that ring is square with cylinder wall.
3. Measure space or gap between ends of ring with a feeler gauge. (Figure 11)
4. If gap between ends of ring is below specifications, remove ring and try another for fit.
5. Fit each compression ring to cylinder in which it is going to be used.
6. Clean and inspect pistons, if not previously done.

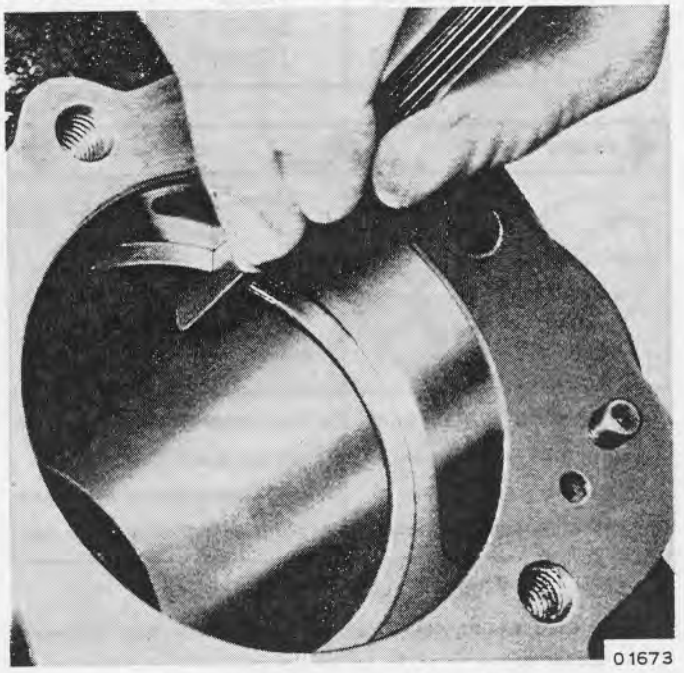

Figure 11. Checking Ring Gap

7. Slip outer surface of top and second compression ring into respective piston ring groove and roll ring entirely around the groove (Figure 12) to make sure that ring is free. If binding occurs at any point, determine cause. If caused by ring groove, remove by dressing with a fine cut file. If binding is caused by a distorted ring, check a new ring.
8. Install piston ring as shown in Figure 13. The following piston ring expanders are available for ring installation.
   a. Install oil ring spacer in groove and insert anti-rotation tang in oil hole.
   b. Hold spacer ends butted and install lower steel oil ring rail with gap properly located.

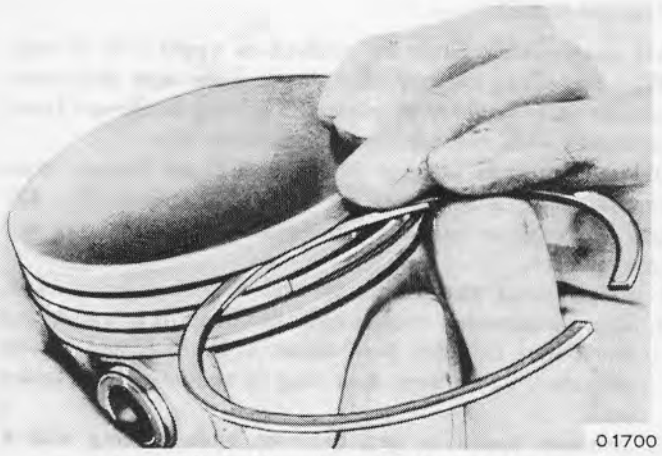

Figure 12. Rolling Ring in Ring Groove

Model	Tool Number
283	J-8021
327 and 350	J-8032
409	J-7117
427 and 482	J-22250

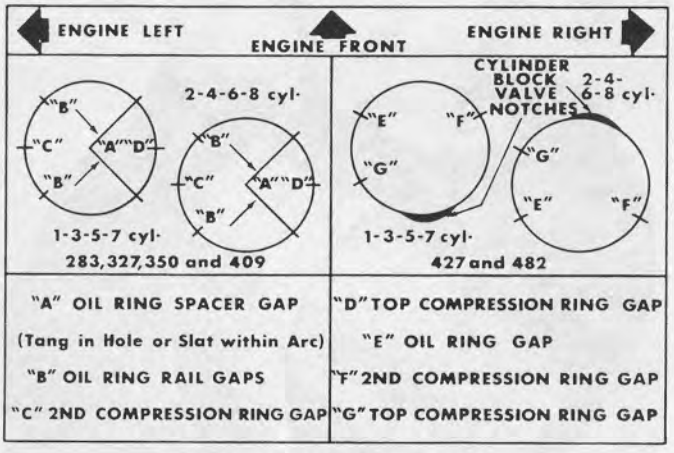

Figure 13. Ring Gap Location

c. Install upper steel oil ring rail with gap properly located.
d. Flex the oil ring assembly to make sure ring is free. If binding occurs at any point, the cause should be determined and, if caused by ring groove, remove by dressing groove with a fine cut file. If binding is caused by a distorted ring, check a new ring.
e. Install second compression ring expander, then ring with gaps properly located.
f. Install top compression ring with gap properly located.

9. Proper clearance of piston ring in its piston ring groove is very important to provide proper ring action and reduce wear. Therefore, when fitting new rings, clearances between ring and groove surfaces should be measured. (Figure 14) See "Specifications" Sec. 8.

REASSEMBLY

1. Lubricate piston pin holes in piston and connecting rod to aid pin installation.

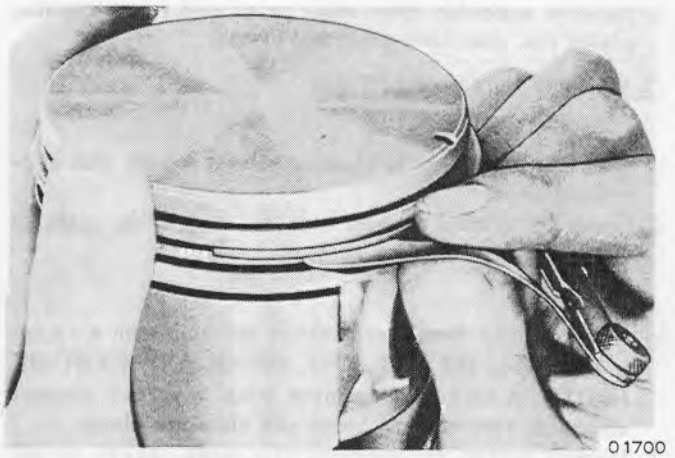

Figure 14. Checking Groove Clearance

2. Place support (with spring and pilot) in place on arbor press. Use tool from following chart (except model 482). On 482 engines, assemble piston and connecting rod (Figure 10) and secure piston pin with 2 keepers.

PISTON PIN TOOL	
Models 283, 327 and 350	- Tool J-9510 (Figure 17)
Models 409 and 427	- Tool J-6994 (Figure 18)

3. Position piston on connecting rod with correct side of piston and connecting rod bearing tangs aligned. (Figure 16)
4. Place piston on support, indexing pilot thru piston and rod.
5. Place installer tool on piston pin, start piston pin into

NOTE: An oven is recommended to heat small end of connecting rod prior to installing piston pin and piston assembly. (Figure 15)

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Figure 15. Connecting Rod Oven

piston and press on tool until pilot bottoms in support.

6. Remove installer tool from connecting rod and piston assembly and check piston for freedom of movement on piston pin.

Figure 16. Connecting Rod and Piston Assembly Reference Chart

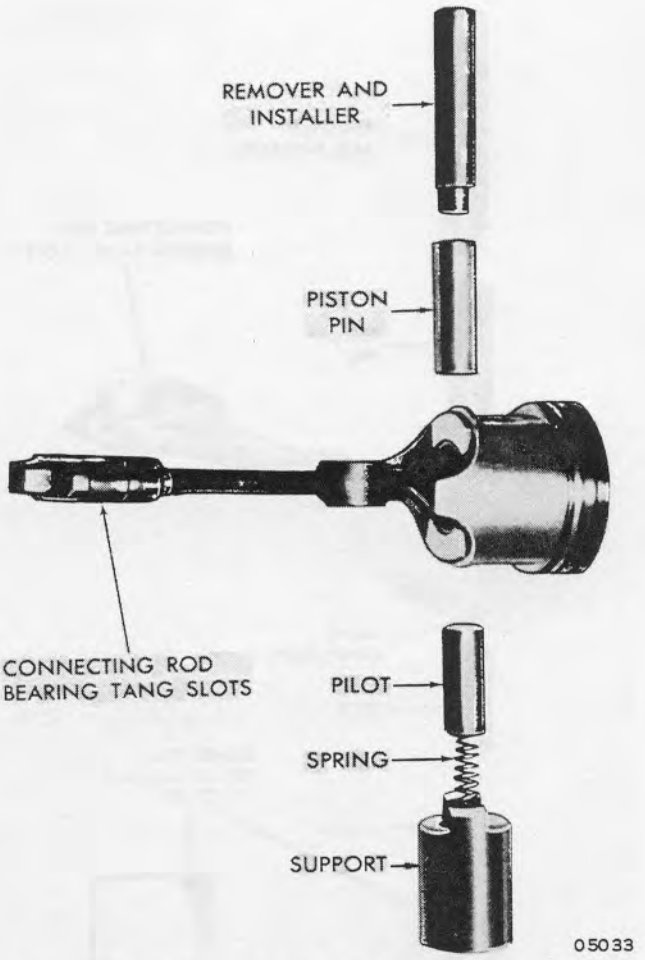

Figure 17. Piston Pin and Tool - 283, 327 and 350

INSTALLATION

NOTE: Cylinder bores must be clean before piston installation. Clean with a light honing, as necessary. After cleaning, swab bores several times with light engine oil and a clean cloth, then wipe with a clean dry cloth.

1. Lubricate connecting rod bearings and install in rods and rod caps.
2. Lightly coat pistons, rings and cylinder walls with light engine oil.
3. With bearing caps removed, install tool J-5239 (3/8") or J-6305 (11/32") on connecting rod bolts.

CAUTION: Be sure ring gaps are properly positioned as previously outlined.

4. Install each connecting rod and piston assembly in its respective bore. Install with connecting rod bearing tangs toward outside of cylinder block. (Figure 19) Use tool J-8307 to compress rings. (Figure 21) Guide connecting rod into place on crankshaft journal with tool J-5239 (3/8") or J-6305 (11/32"). Use a hammer handle and light blows to install piston into bore. Hold ring compressor firmly against cylinder block until all piston rings have entered cylinder bore. (Figure 20 for 409 engines)

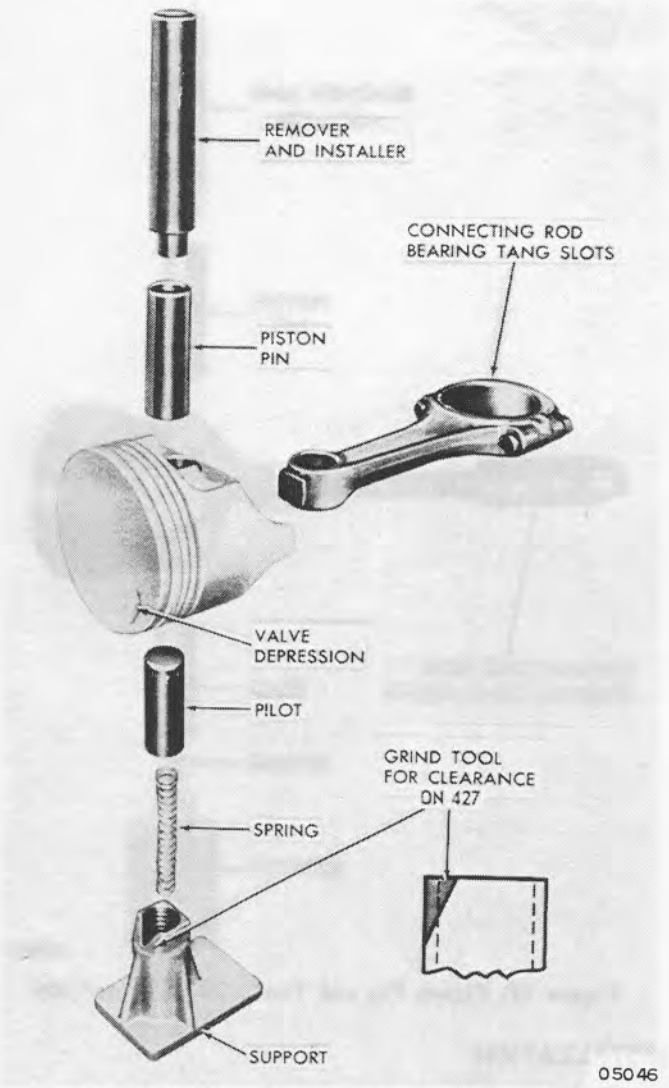

Figure 18. Piston Pin and Tool - 409 and 427

NOTE: Be sure to install new pistons in same cylinders for which they were fitted, and used pistons in same cylinder from which they were removed. Each connecting rod and bearing cap should be marked, beginning at front of engine (1, 3, 5 and 7 in left bank and 2, 4, 6 and 8 in right bank). Numbers on connecting rod and bearing cap must be on same side when installed in cylinder bore. If a connecting rod is ever transposed from one block or cylinder to another, new bearings should be fitted and connecting rod should be numbered to correspond with new cylinder number.

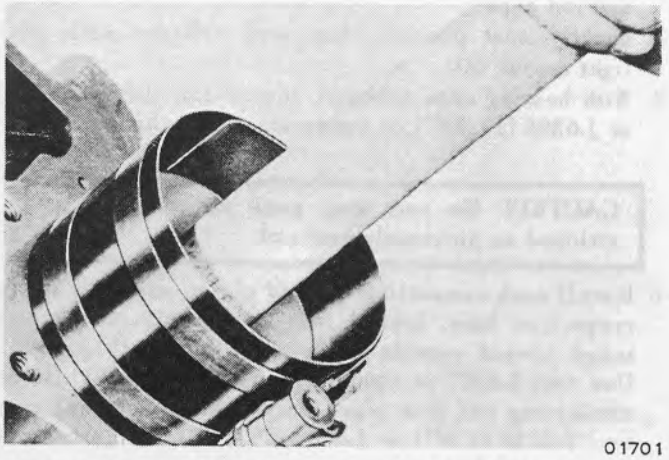

Figure 19. Installing Connecting Rod and Piston Assemblies

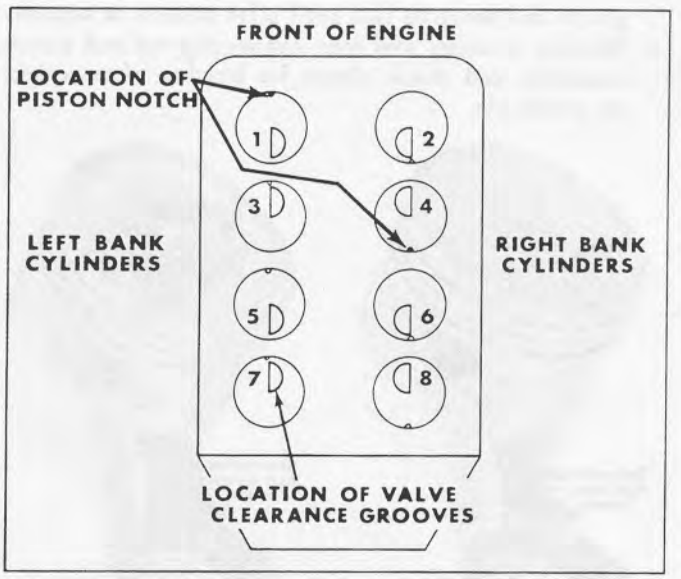

Figure 20. Piston Installed Diagram 409 Engine

5. Remove tool J-5239 or J-6305.
6. Install bearing caps and torque nuts to specification.

NOTE: If bearing replacement is required, refer to "Connecting Rod Bearings".

Figure 21. Connecting Rods-Installed Position - V-8

CRANKSHAFT

REMOVAL

1. Drain block and crankcase oil. Disconnect all hoses.
2. Remove engine from boat.
3. Remove belts and crankshaft pulley.
4. Remove water pump, underpan, flywheel housing and flywheel. Place engine in stand.
5. Remove torsional damper and crankcase front end cover.
6. Remove camshaft sprocket and timing chain (if applicable). Remove crankshaft oil slinger.
7. Remove crankshaft sprocket.
8. Remove oil pan and oil pump.
9. Make sure all bearing caps (main and connecting rods) are marked so they can be installed in their original locations. Remove connecting rod bearing caps, then push piston and rod assemblies toward heads.
10. Remove main bearing caps and carefully lift crankshaft out of cylinder block. Remove rear main bearing oil seal from cylinder block and rear main bearing cap.
11. If new main and/or connecting rod bearings are to be installed, remove main bearing inserts from cylinder block and bearing caps, and/or connecting rod bearing inserts from connecting rod and caps. Install new bearings following procedures outlined in this section.

CLEANING and INSPECTION

1. Wash crankshaft in solvent and dry with compressed air.
2. Measure main bearing journals and crankpin dimensions with a micrometer for out-of-round, taper or undersize (see "Specifications").
3. Check crankshaft for runout (by supporting at front and rear main bearings journals in "V" blocks) and check at front and rear intermediate journals with a dial indicator (see "Specifications").
4. Replace or recondition crankshaft if not meeting specifications.

INSTALLATION

NOTE: Be sure that all bearings and crankshaft journals are clean.

1. Install a new rear main bearing oil seal in cylinder block and rear main bearing cap.
2. Carefully lower crankshaft into place. BE CAREFUL NOT TO DAMAGE BEARING SURFACE.
3. Check clearance of each main bearing following procedure outlined under "Main Bearing Clearance" in this section. If bearing clearances are satisfactory, apply a light coat of engine oil to journals and bearings.
4. Install all bearing caps and bolts. Torque all main bearing cap bolts to specifications. When tightening rear main bearing cap, torque bolts 10 to 12 ft. lbs. first, then tap end of crankshaft to the rear with lead hammer (this will locate bearing cap and bearing). Then tap crankshaft forward (this will line up both upper and lower crankshaft bearing thrust surfaces).
5. Check crankshaft end play by forcing crankshaft to its extreme front position. Check at front end of rear main bearing with feeler gauge. (Figure 22) Clearance should be from .001" to .006" with new bearing. If greater than maximum .009" clearance, rear main bearing must be replaced. (.001"=.025mm)

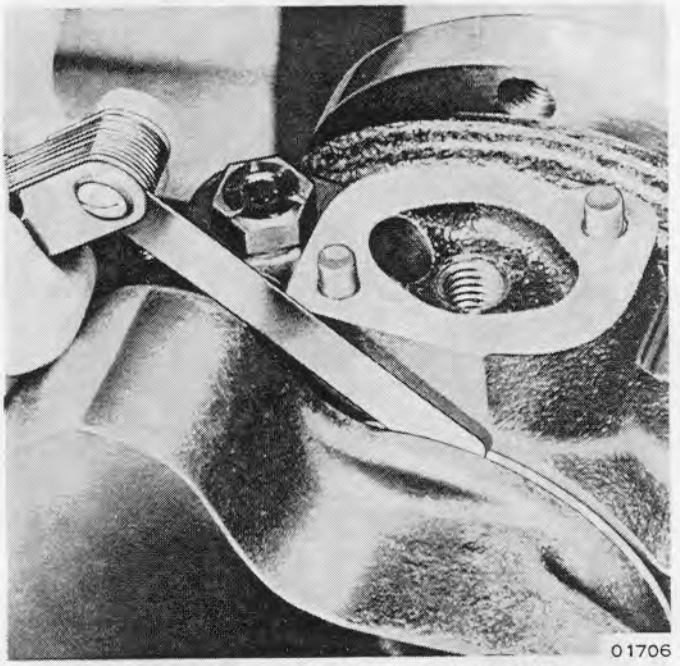

Figure 22. Measuring Crankshaft End Play

6. Install oil pump and pan as outlined.
7. Install crankshaft sprocket, oil slinger, camshaft sprocket and timing chain, if applicable.
8. Install crankcase front cover and torsional damper.
9. Remove engine from repair stand and install water pump, flywheel, flywheel housing and underpan.
10. Install crankshaft pulley and belts.
11. Install engine in boat, fill crankcase and install hoses.

TIMING CHAIN and/or SPROCKETS

283, 327, 350 and 409 Models

REPLACEMENT

1. Remove torsional damper and crankcase front cover as outlined.
2. Crank engine until marks on camshaft and crankshaft sprockets are in alignment. (Figure 1)
3. Remove camshaft sprocket to camshaft bolts.
4. Remove camshaft sprocket and timing chain together. Sprocket is a light press fit on camshaft. If sprocket does not come off easily, a light blow on lower edge of sprocket (with a plastic mallet) should dislodge the sprocket.

Figure 1. Timing Sprocket Marks

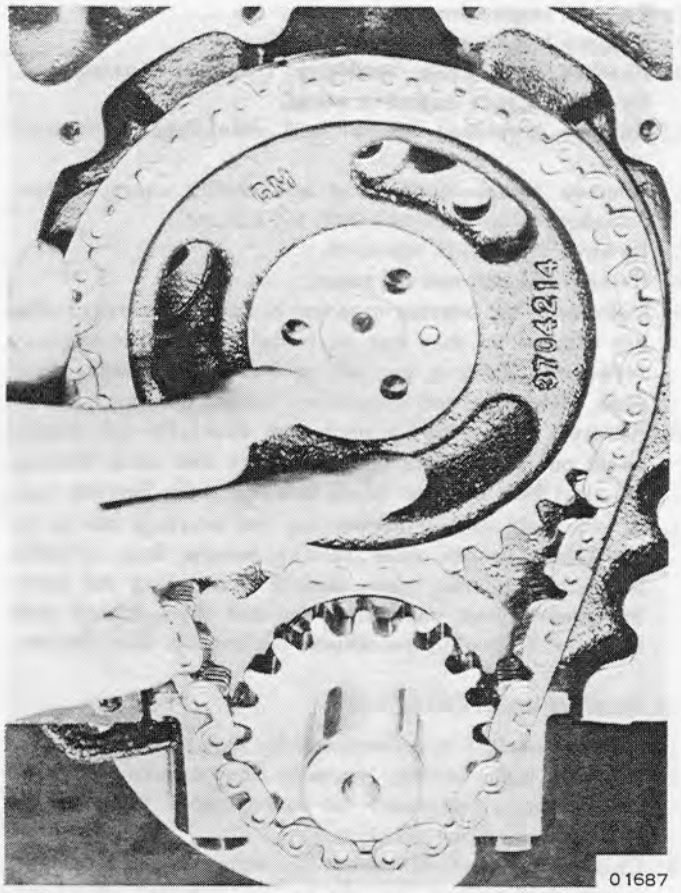

Figure 2. Installing Timing Chain

5. Install timing chain on camshaft sprocket. Hold sprocket vertical with chain hanging down and orient to align marks on camshaft and crankshaft sprockets. (Figure 2)

   NOTE: Do not attempt to drive sprocket on camshaft, as welsh plug at rear of engine can be dislodged.

6. Draw camshaft sprocket onto camshaft, using the 3 mounting bolts. Torque to specifications.
7. Lubricate timing chain with engine oil. Install crankcase front cover and torsional damper as outlined.

CAMSHAFT

MEASURING LOBE LIFT

NOTE: Procedure is similar to checking valve timing. If improper valve operation is indicated, measure lift of each push rod in consecutive order and record readings.

1. Remove valve mechanism as outlined.
2. Position indicator with ball socket adapter (tool J-8520) on push rod. (Figure 3) Be sure that push rod is in lifter socket.
3. Rotate crankshaft damper slowly in direction of rotation until lifter is on heel of cam lobe. At this point, push rod will be in its lowest position.
4. Set dial indicator on zero, then rotate balancer slowly (or attach an auxiliary starter switch and "bump" engine over) until push rod is in fully raised position.
5. Compare total lift, recorded from dial indicator, with specifications.
6. Continue to rotate engine until indicator reads zero. This will be a check on accuracy of original indicator reading.
7. If camshaft readings for all lobes are within specifications, remove dial indicator assembly.
8. Install and adjust valve mechanism as outlined.

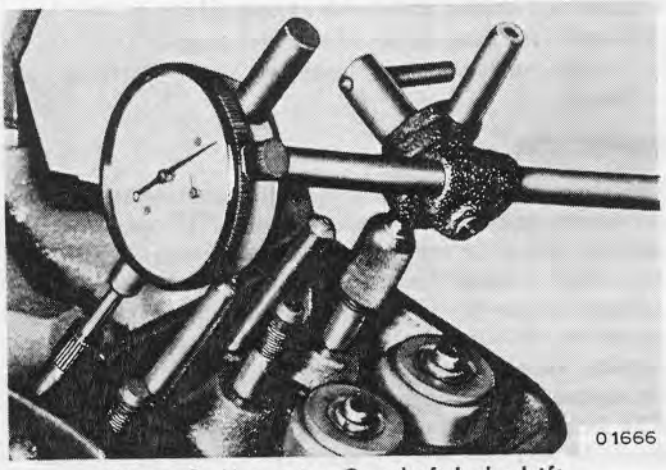

Figure 3. Measuring Camshaft Lobe Lift

REMOVAL

1. Remove valve lifters as outlined.
2. Remove crankcase front cover as outlined.
3. Remove fuel pump push rod by removing fuel pump.
4. Complete camshaft removal as follows:

WITH TIMING CHAIN

a. Remove camshaft sprocket bolts, then remove camshaft sprocket and timing chain.

NOTE: Sprocket is a light press fit on camshaft. To dislodge, tap lightly on lower edge of camshaft sprocket with a plastic hammer.

b. Install two 5/16-18 bolts in camshaft sprocket bolt holes and carefully remove camshaft. (Figure 4)

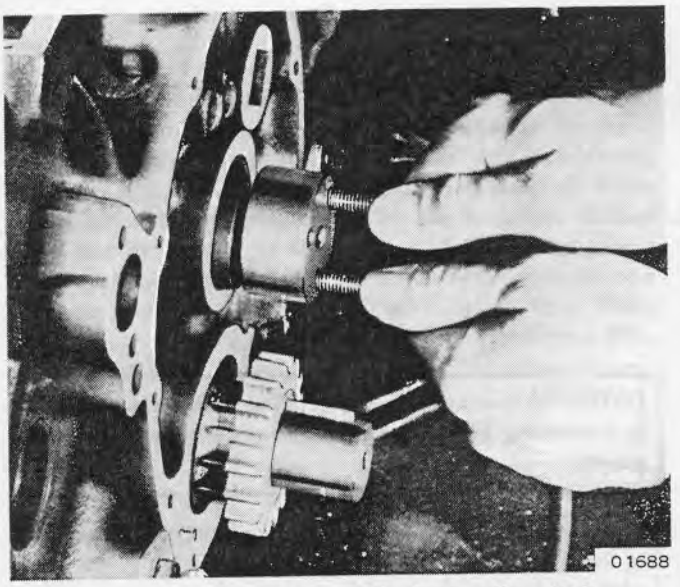

Figure 4. Removing and Replacing Camshaft

WITH TIMING GEAR

a. Remove camshaft thrust plate screws (through holes in camshaft gear).
b. Remove camshaft and gear as an assembly. (Figure 5)

CAUTION: All camshaft journals are same diameter, and care must be used in removing camshaft to avoid damage to bearings.

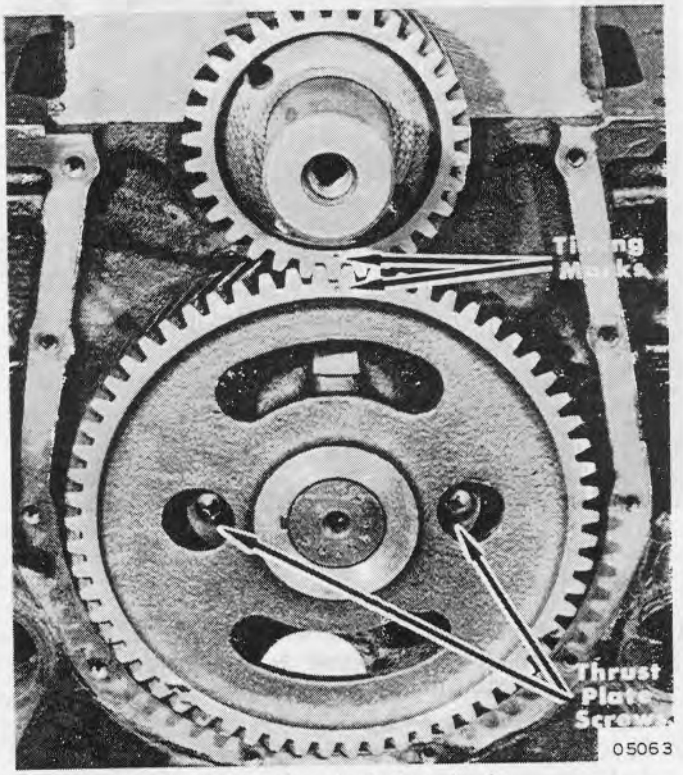

Figure 5. Camshaft Gear Marks

INSTALLATION

NOTE: When installing new camshaft, lubricate camshaft lobes with "Molykote" or equivalent.

WITH TIMING CHAIN

1. Install two 5/16-18 bolts in camshaft bolt holes, then lubricate camshaft journals with engine oil and install camshaft, being careful not to damage bearings. (Figure 4) Remove the two 5/16-18 bolts.
2. Install timing chain on camshaft sprocket, then align marks on camshaft and crankshaft sprockets and connect chain to crankshaft sprocket. Align dowel on camshaft with dowel hole in camshaft sprocket and install sprocket on camshaft. (Figure 2)

CAUTION: Do not hammer crankshaft sprocket onto camshaft. This may loosen rear camshaft welsh plug.

3. Draw camshaft sprocket into camshaft, using the mounting bolts. Torque bolts to specifications.
4. Lubricate timing chain with engine oil.
5. Install fuel pump push rod and fuel pump.
6. Install crankcase front cover and valve lifters as outlined.

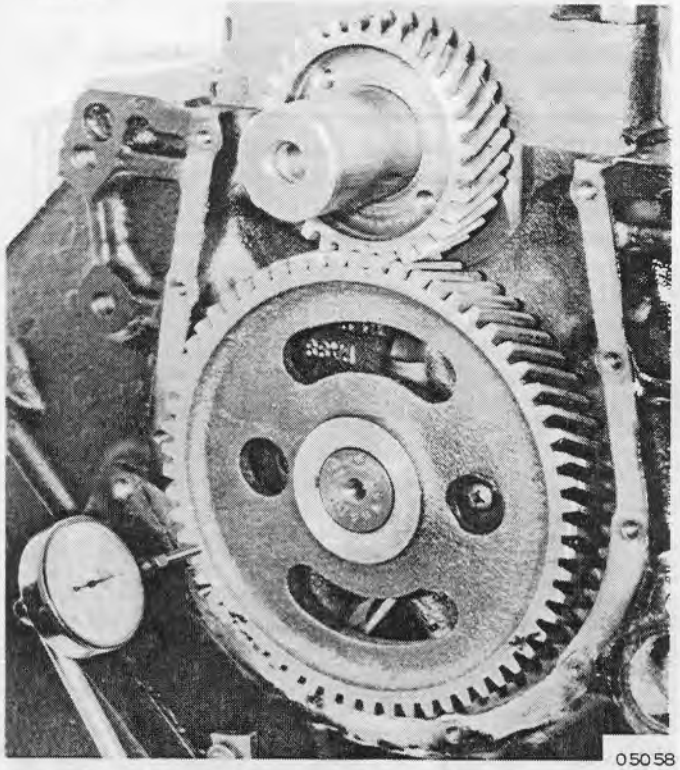

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Figure 6. Camshaft Gear Runout

WITH TIMING GEAR

1. Lubricate camshaft journals with engine oil, then rotate crankshaft and camshaft so that marks on gears will line up. Install camshaft and gear assembly, being careful not to damage bearings. (Figure 5)
2. Check camshaft and crankshaft gear runout with a dial indicator. Camshaft gear runout should not exceed .004", and crankshaft gear runout should not exceed .003". (Figure 6) (.001"=.025mm)

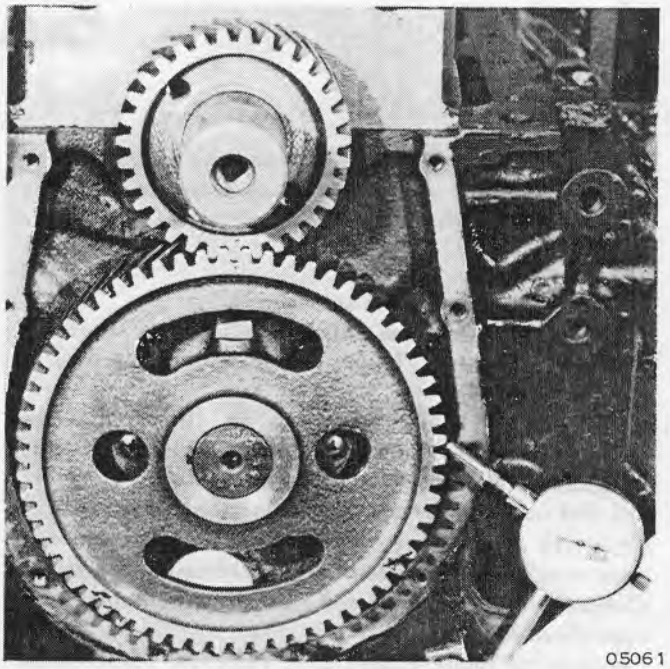

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Figure 7. Camshaft Gear Backlash

3. Check backlash between timing gear teeth with a dial indicator. Backlash should not be less than .004" nor more than .006". (Figure 7)
4. Lubricate timing gears with engine oil.
5. Install fuel pump push rod and fuel pump.
6. Install crankcase front cover and valve lifters as outlined.

INSPECTION

Measure camshaft bearing journals with a micrometer for out-of-round condition. If journals exceed .001" out-of-round, camshaft should be replaced. (.001" = .025mm)

Also check camshaft for alignment with "V" blocks and dial indicator (Figure 8) which indicates exact amount camshaft is out-of-true. If out more than .002" dial indicator reading, camshaft should be replaced.

On engines with timing gears, inspect camshaft gear and thrust plate for wear or damage. Measure camshaft end play which should be .001" to .005". (Figure 9)

CAMSHAFT GEAR REPLACEMENT

1. If inspection indicates that camshaft, gear or thrust plate should be replaced, gear must be removed from camshaft with camshaft gear remover tool J-971.
2. Place camshaft through gear remover, place end of remover on table of a press and press shaft out of gear. (Figure 9)

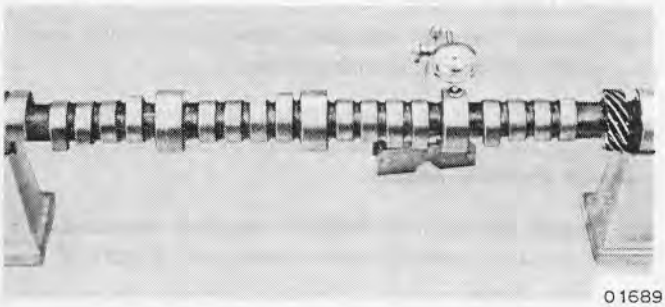

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Figure 8. Checking Camshaft Alignment

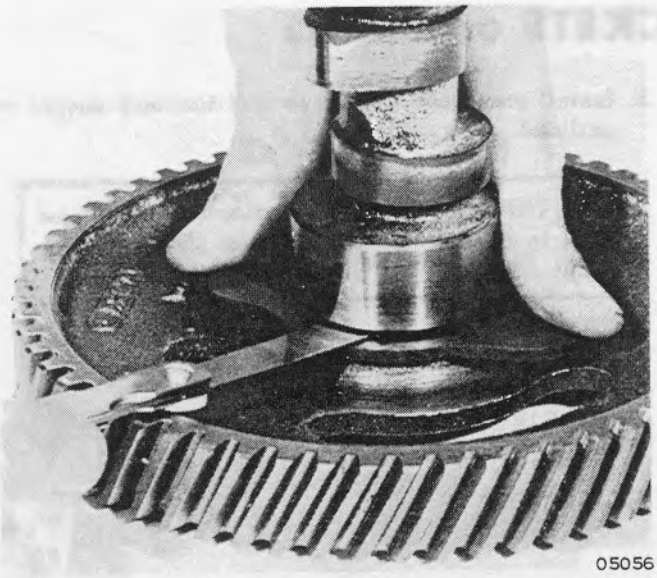

Figure 9. Checking Thrust Plate Clearance

CAUTION: Position thrust plate so that woodruff key in shaft does not damage it when shaft is pressed out of gear. Also support hub of gear, or gear will be seriously damaged.

3. To assemble camshaft gear, thrust plate and gear spacer ring to camshaft, firmly support camshaft at back of front journal in an arbor press. (Figure 10)

IMPORTANT: On 427 and 482 models, install thrust plate with oil grooves toward camshaft gear.

4. Place gear spacer ring and thrust plate over end of shaft, and install woodruff key in shaft keyway. Press camshaft gear onto shaft until it bottoms against gear spacer ring. End clearance of thrust plate should be .001" to .005" (0.025mm to 0.127mm). (Figure 9)

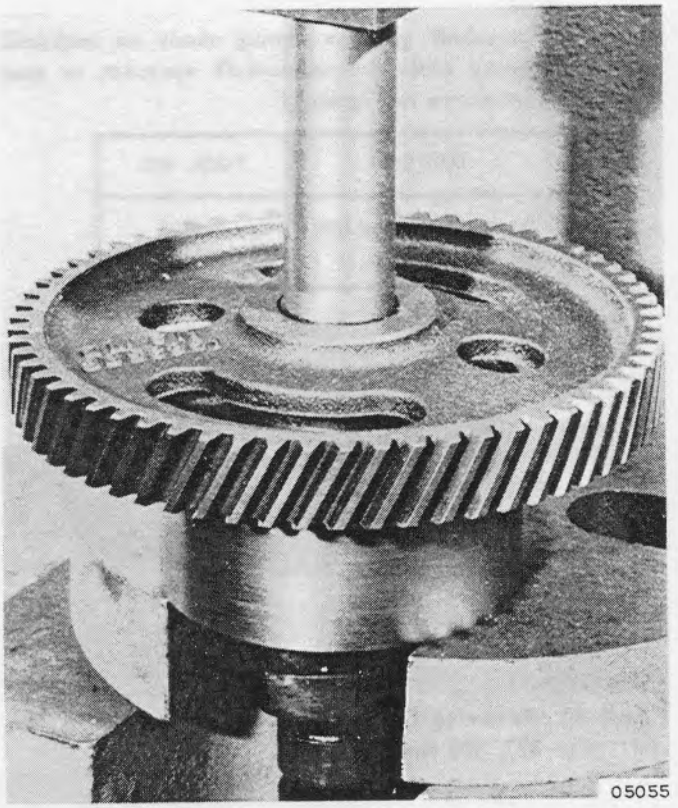

Figure 10. Removing Camshaft Gear

CRANKSHAFT SPROCKETS or GEARS

REMOVAL

1. Remove torsional damper and crankcase front cover as outlined.
2. Remove camshaft gear or timing chain as outlined.
3. Use following tools for crankshaft sprocket or gear removal, as shown in Figure 11.

MODEL	TOOL NO.
283, 327, 350 and 409 427 and 482	J-5825 J-8105

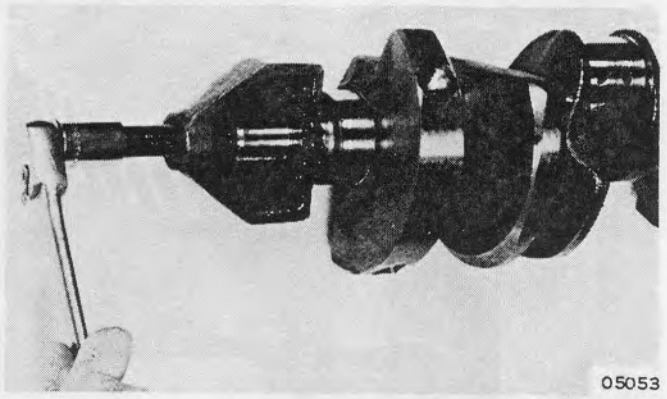

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Figure 11. Removing Crankshaft Gear or Sprocket - 283, 327, 350 and 409

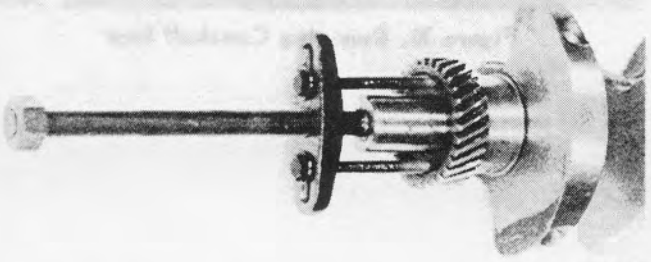

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Figure 11A. Removing Crankshaft Gear or Sprocket - 427 and 482

NOTE: On 427 and 482 engines, be sure that removal tool will not damage retaining bolt threads.

INSTALLATION

1. Use following tools for installation of crankshaft sprocket or gear, as shown in Figure 12 or 12A.
2. Install camshaft gear or timing chain as outlined.
3. Install crankcase front cover and torsional damper as outlined.

CAUTION: On 427 and 482 models, install tool bolt in crankshaft with sufficient thread engagement.

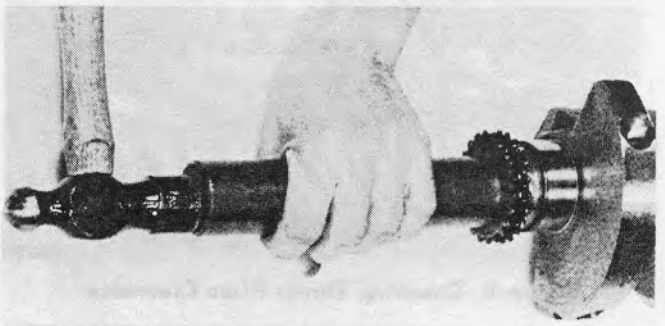

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Figure 12. Installing Crankshaft Gear or Sprocket - 283, 327, 350 and 409

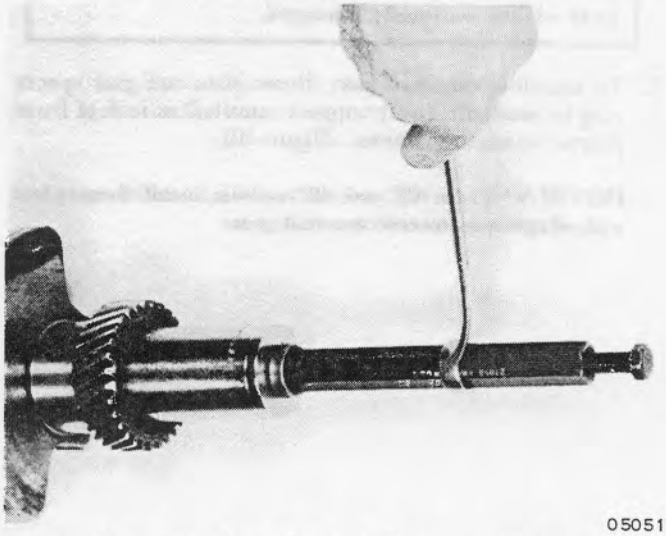

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Figure 12A. Installing Crankshaft Gear or Sprocket - 427 and 482

MODEL	TOOL NO.
283, 327, 350 and 409 427 and 482	J-5590 J-21058

CAMSHAFT BEARINGS

INSPECTION

With camshaft removed, inspect bearings for wear or damage and replace if necessary.

REMOVAL

Camshaft bearings can be replaced while engine is disassembled for overhaul or without complete disassembly. To replace bearings without complete disassembly, remove camshaft and crankshaft, leaving cylinder heads attached and pistons in place. Before removing crankshaft, tape threads of connecting rod bolts to prevent damage to crankshaft. Fasten connecting rod against sides of engine so that they will not interfere while replacing camshaft bearings.

1. With camshaft and crankshaft removed, drive camshaft rear plug from cylinder block.

   NOTE: This procedure is based on removal of bearings center of engine first, thus requiring a minimum amount of turns to remove all bearings.

2. Using tool set J-6098-1 (with nut and thrust washer installed to end of threads), position pilot in front camshaft bearing and install puller screw through pilot.

   NOTE: Tool adaptor J-6098-8 is used with tool set J-6098 for replacing model 427 and 482 cam bearings. Combination of above tools is tool set J-6098-01.

3. Install J-6098-1 tool with shoulder toward bearing. Be sure a sufficient amount of threads are engaged.
4. Using 2 wrenches, hold puller screw while turning nut. When bearing has been pulled from bore, remove tool and bearing from puller screw. (Figure 13)
5. Remove remaining bearings (except front and rear) in same manner. It will be necessary to position pilot in rear camshaft bearing to remove rear intermediate bearing.

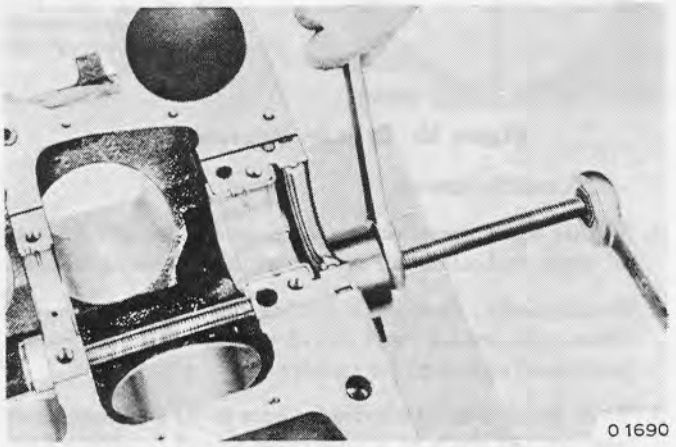


Figure 13. Replacing Camshaft Bearings

6. Assemble J-6098-1 tool on driver handle and remove front and rear camshaft bearings by driving toward center of cylinder block. (Figure 13)

INSTALLATION

Install front and rear camshaft bearings first. These bearings act as guides for pilot and center the remaining bearings being pulled into place.

1. Assemble tool J-6098-1 on driver handle and install front and rear camshaft bearings by driving toward center of cylinder block. (Figure 14)

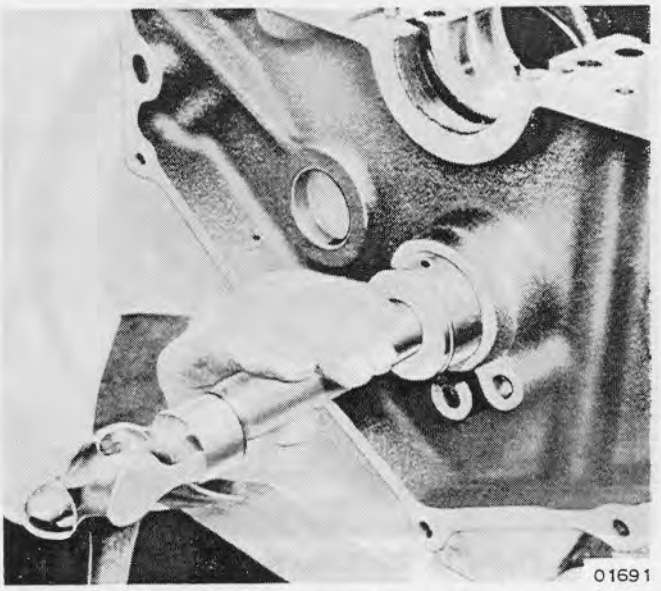


Figure 14. Replacing Front Camshaft Bearing

CAUTION: Oil holes in bearings must line up with oil holes in cylinder block.

2. Using tool set J-6098 (with nut and thrust washer installed to end of threads), position pilot in front camshaft bearing and install puller screw through pilot.
3. Position camshaft bearing in bore, then install J-6098-1 tool in puller screw with shoulder toward bearing.
4. Using 2 wrenches, hold puller screw while turning nut. After bearing has been pulled into bore, remove tool from puller screw and check alignment of oil hole in camshaft bearing. (Figure 13)
5. Install remaining bearings in same manner. It will be necessary to position pilot in rear camshaft bearing to install rear intermediate bearing.
6. Install a new camshaft rear plug.

   NOTE: Install plug flush to 1/32" (.8mm) deep and parallel with rear surface of cylinder block.

CYLINDER BLOCK

OIL FILTER BY-PASS VALVE INSPECTION and REPLACEMENT

With oil filter removed, check spring and fibre valve for operation. Inspect for a cracked or broken valve. If replacement is necessary, oil filter adaptor and by-pass valve assembly must be replaced as an assembly. Clean valve chamber in cylinder block thoroughly. Torque retaining screws to specifications. (Figure 15)

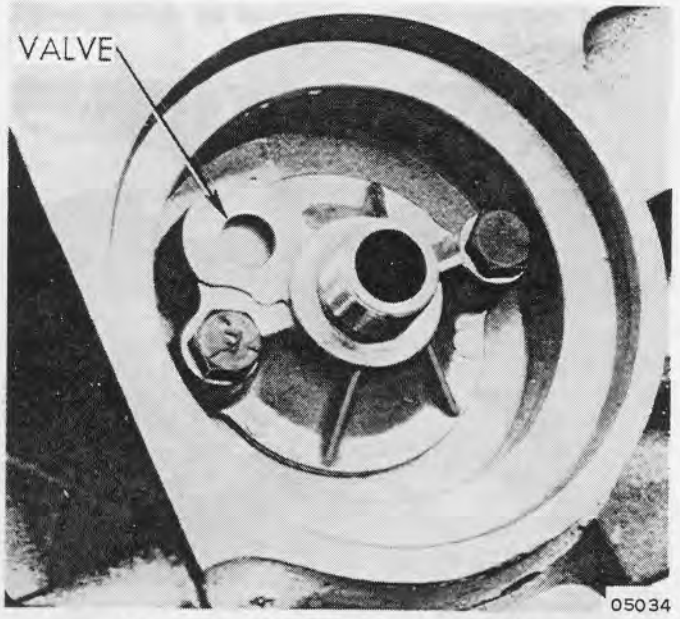


Figure 15. Oil Filter By-Pass Valve

CLEANING and INSPECTION

1. Remove all engine components as previously outlined.
2. Wash cylinder block thoroughly in cleaning solvent and clean all gasket surfaces.
3. Remove oil gallery plugs and clean all oil passages.

   NOTE: These plugs may be removed with a sharp punch, or they may be drilled and pried out.

4. Clean and inspect water passages in cylinder block.
5. Inspect cylinder block for cracks in cylinder walls, water jacket valve lifter bores and main bearing webs.
6. Measure cylinder walls for taper, out-of-round or excessive ridge at top of ring travel. This should be done with a dial indicator or inside micrometer. (Figure 16) Carefully work gauge up and down cylinder to determine taper and turn it to different points around cylinder wall to determine out-of-round condition. If cylinders exceed specifications, honing or boring will be necessary. (Figure 17)

REPAIRS

CYLINDER CONDITIONING

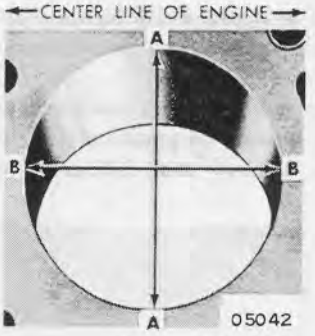
1. Performance of the following operation depends upon engine condition at time of repair.
2. If cylinder block inspection indicates that block is suitable for continued use (except for out-of-round or tapered cylinders), they can be conditioned by honing or boring.
3. If cylinders have less than .005" taper or wear, they can be conditioned with a hone and fitted with high limit standard size piston. A cylinder bore of less than .005" wear or taper may not clean up entirely when fitted to a high limit piston. To entirely clean up the bore, it will be necessary to rebore for an oversize piston. If more than .005" taper or wear, bore and hone to smallest oversize that will permit complete resurfacing of all cylinders. (.005"=.127mm)
4. When pistons are being fitted and honing is not necessary, cylinder bores may be cleaned with a hot water and detergent wash. After cleaning, swab cylinder bores several times with light engine oil and a clean cloth, then wipe with a clean dry cloth.

CYLINDER BORING

1. Before using any type boring bar, file off top of cylinder block to remove dirt or burrs. This is very important to prevent boring bar tilt and result that rebored cylinder wall is not at right angles to crankshaft.
2. Measure piston to be fitted with a micrometer, measuring at center of piston skirt and at right angles to piston pin. Bore cylinder to same diameter as piston and hone to give specified clearance.

   NOTE: Hone cylinders as outlined under "Cylinder Honing and Piston Fitting".

3. Carefully observe instructions furnished by manufacturer of equipment being used.



"A" = At right angle to centerline of engine
"B" = Parallel to centerline of engine
"Out-of-round" = Difference between "A" and "B"
"Taper" = Difference between measurement at top of cylinder bore and "A" measurement at bottom of cylinder bire.

Figure 16. Cylinder Measurement

CYLINDER HONING

1. Follow hone manufacturer s recommendations for use of hone and cleaning and lubrication during honing.
2. Occasionally, during the honing operation, thoroughly clean cylinder bore and check piston (selected for the individual cylinder) for correct fit.
3. When finish-honing a cylinder bore to fit a piston, move hone up and down at a sufficient speed to obtain very fine uniform surface finish marks in a cross-hatch pattern of approximately 45° to 65° included angle. Finish marks should be clean but not sharp, free from imbedded particles and torn or folded metal.
4. Permanently mark piston (for cylinder to which it has been fitted) and proceed to hone cylinders and fit remaining pistons.

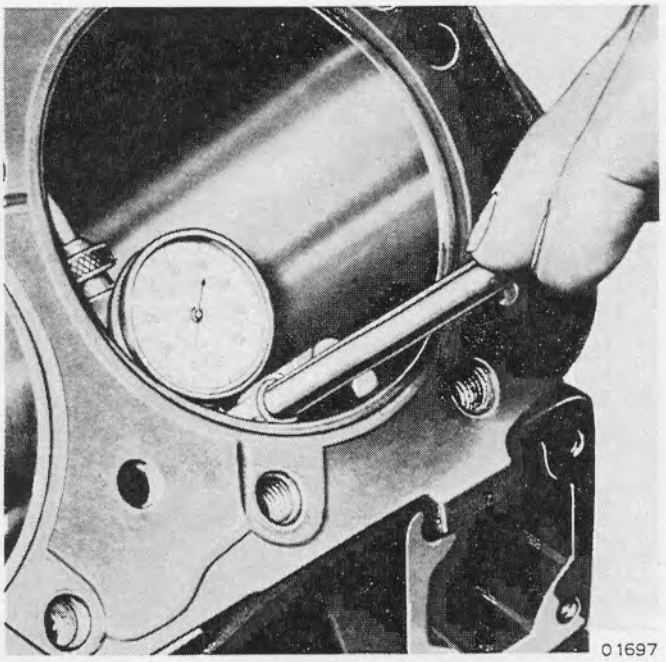


Figure 17. Measuring Cylinder Bore

CAUTION: Handle pistons with care and do not attempt to force them through cylinder until cylinder is honed to correct size, as this type piston can be distorted by careless handling.

5. Thoroughly clean cylinder bores with hot water and detergent. Scrub well with a stiff bristle brush and rinse thoroughly with hot water. It is extremely essential that a good cleaning operation be performed. If any abrasive material remains in cylinder bores, it will rapidly wear new rings and cylinder bores in addition to bearings lubricated by the contaminated oil. Swab bores several times with light engine oil and a clean cloth, then wipe with a clean dry cloth. Cylinder should not be cleaned with kerosene or gasoline. Clean remainder of cylinder block to remove excess material spread during honing operation.

PISTON SELECTION

1. Check USED piston to cylinder bore clearance as follows:
   a. Measure "cylinder bore diameter" with a telescope gauge (2-1/2" [63.5mm] from top of cylinder bore).
   b. Measure "piston diameter" (at skirt across center line of piston pin).
   c. Subtract piston diameter from cylinder bore diameter to determine "piston-to-bore clearance".
   d. Determine if "piston-to-bore clearance" is in acceptable range shown in specifications.
2. If used piston is not satisfactory, check Piston Size Chart, following, and determine if a new piston can be selected to fit cylinder bore within acceptable range.
3. If cylinder bore must be reconditioned, measure new piston diameter (across centerline of piston pin), then hone cylinder bore to correct clearance (preferable range).
4. Mark piston to identify cylinder for which it was fitted.

OVERSIZE PISTONS AVAILABLE

ENGINE DISPLACEMENT	SIZE		
	.001"	.020"	.030"
283	3.8760" to 3.8770"	3.8937" to 3.8957"	
327 and 350	4.0010" to 4.0020"	4.0187" to 4.0207"	4.0287" to 4.0307"
409	4.3110" to 4.3120"		4.3380" to 4.3400"
427	4.2485" to 4.2495"		4.2780" to 4.2800"
482	4.2485" to 4.2495"	4.2680" to 4.2700"	4.2780" to 4.2800"

Metric Conversion: 1" = 25.4mm

SECTION 5 - ENGINE

MERCRUISER

PART D - ENGINE MECHANICAL, V-8 FORD

MERCURY MARINE

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ENGINE MECHANICAL

V-8 (302 and 351 Cu. In.) FORD ENGINE

For MerCruiser 888-215-225 and 255

TOOLS

* *All "J" (Special) Tools Listed Herein May Be Purchased From:*

Kent-Moore, Inc.
28635 Mound Road
Warren, Michigan 48089

* *All "T" Prefix (Special) Tools Herein May Be Purchased From:*

Owatonna Tools, Inc.
Attn: Ford Order Desk
Owatonna, Minnesota 55060

* *If ordering tool number(s) shown in discussion on following pages, number(s) may be superseded by newer tool(s) which will be sent by tool manufacturer listed above.*

GENERAL

Some repairs, which are listed in this section, must be completed with the engine removed from the boat. Type of repair and boat design determine if the engine is to be removed.

Place engine on an engine stand for major repairs.

Right hand and left hand rotation engines have similar repair procedures, as outlined in this section. Component crankshafts, camshafts, front and rear crankshaft seals and circulating water pumps, however, vary between right and left hand rotating engines.

INTAKE MANIFOLD

REMOVAL

1. Drain water from cylinder block.
2. Remove coil bracket bolt and move coil aside.
3. Remove temperature sender leads.
4. Remove distributor cap and move cap aside.
5. Remove 2 bolts which secure thermostat housing to intake manifold.
6. Remove carburetor fuel inlet line and throttle linkage.
7. Disconnect crankcase vent hose at rocker arm cover.
8. Remove manifold attaching bolts and nuts. Remove manifold and carburetor as an assembly. It may be necessary to pry intake manifold away from cylinder head(s). Use caution to avoid damage to gasket sealing surfaces.
9. Remove intake manifold gaskets and seals. Discard intake manifold attaching bolt sealing washers.

CLEANING

1. Remove all gasket material from machined surfaces of manifold.
2. Clean manifold in a suitable solvent and dry with compressed air.

INSPECTION

1. Inspect manifold for cracks, damaged gasket surfaces or other defects.
2. Replace studs which are stripped or damaged.
3. Remove all filings and foreign matter that may have entered manifold during repair.

INSTALLATION

1. If replacing manifold assembly, transfer engine lifting eye, temperature sending unit, carburetor and spacer. Install new gasket.
2. Clean mating surface of intake manifold, cylinder heads and cylinder block. Use a suitable solvent to remove all traces of oil. Coat cylinder block seal surfaces with contact adhesive.
3. Position new seals on cylinder block and new gaskets on cylinder heads with gaskets interlocked with seal tabs. Be sure that holes in gaskets are aligned with holes in cylinder heads.
4. Carefully lower intake manifold into position on cylinder block and cylinder heads. After intake manifold is in place, run a finger around the seal area to make sure that seals are in place.
5. Be certain that holes in manifold gaskets and manifold are in alignment. Using new sealing washers, install intake manifold attaching bolts and nuts. Torque intake manifold bolts in 2 steps. Torque all bolts in sequence to specifications. After completing remaining assembly steps, operate engine until it reaches normal operating temperature, then retorque manifold bolts to specifications in sequence shown in Figure 1.
6. Install thermostat housing and temperature sender lead.
7. Install carburetor fuel inlet line.
8. Connect crankcase vent hose. Install coil.
9. Connect throttle linkage.
0. Operate engine at fast idle and check all hose connections and gaskets for leaks. When engine temperatures have stabilized, adjust engine idle speed and idle fuel mixture.

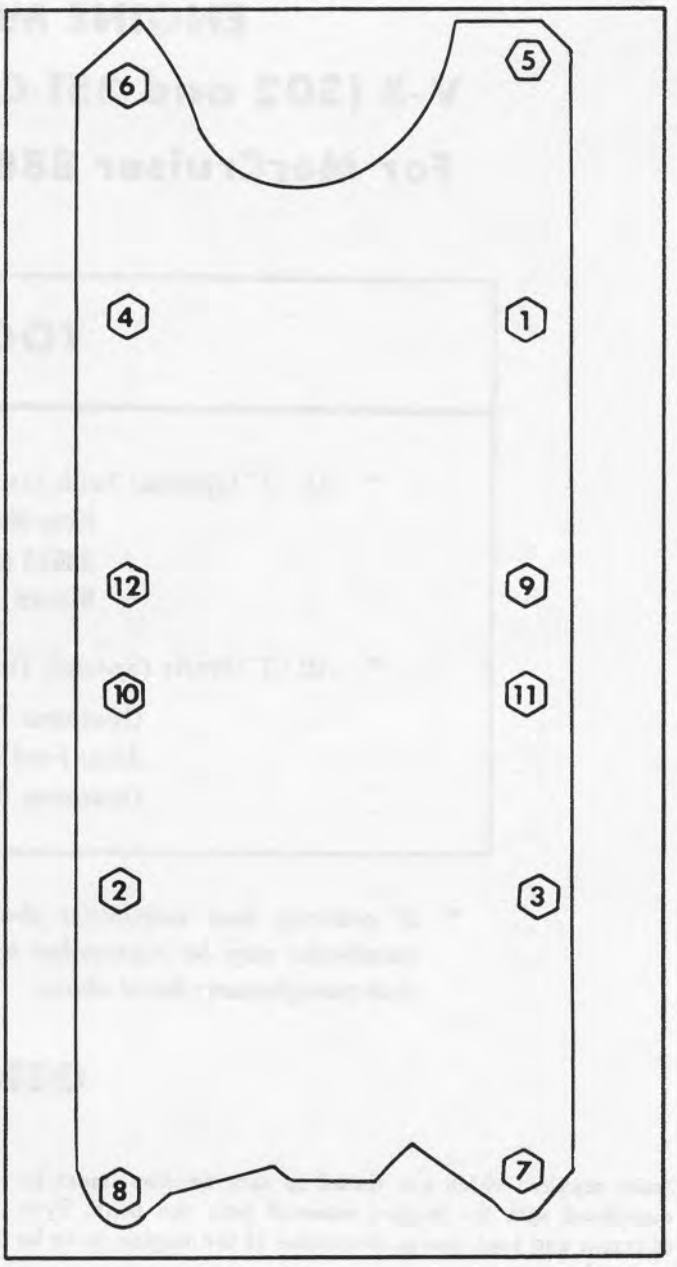

Figure 1. Intake Manifold Torque Sequence

EXHAUST MANIFOLDS

REMOVAL

1. Remove cooling hose from manifold.
2. Remove dipstick housing bracket and fuel filter mount from port manifold.
3. Disconnect exhaust hoses. Drain water from manifold housing and elbow.
4. Remove attaching bolts and washers, then remove manifold.

CLEANING and INSPECTION

1. Clean gasket material from all surfaces and wash parts in solvent.
2. Inspect all parts carefully. Machined surfaces must be clean and free of all marks or deep scratches, or water leaks may result.
3. Check water passages for sand, silt or foreign material. Passages must be clean for efficient cooling.
4. Pipe plugs may be removed from exhaust manifold elbow and exhaust pipe elbow, if more thorough inspection is desired.

INSTALLATION

1. Clean mating surfaces of exhaust manifold and cylinder head.
2. Position exhaust manifold on cylinder head with new gaskets and install attaching bolts and washers. Torque bolts to specifications from center to ends.
3. Install exhaust hoses and drain plugs.
4. Install dipstick housing bracket and fuel filter on port manifold.
5. Install cooling inlet hose.
6. Start engine and check for leaks.

ROCKER ARM COVER

REMOVAL

1. Remove carburetor vent hose from starboard cover.
2. Remove attaching bolts and remove rocker arm cover(s).

INSTALLATION

1. Clean gasket surfaces and position cover(s) in place with new gasket.
2. Install rocker cover bolts with harness clamps on right manifold and torque cover(s) to specifications shown in Section 8.
3. Install carburetor vent hose in starboard rocker cover.

VALVE CLEARANCE

If a noise is present in valve train (which is not caused by a collapsed hydraulic lifter), use the following procedure to check for worn components in the valve train. If check indicates that clearance is not to specifications, replace worn parts in valve train to bring limit within specifications.

1. Position No. 1 piston at TDC (position "A") at end of compression stroke. Use chalk to mark points "B" and "C" approximately 90° apart. (Figure 2) Adjust only valves indicated for position "A".

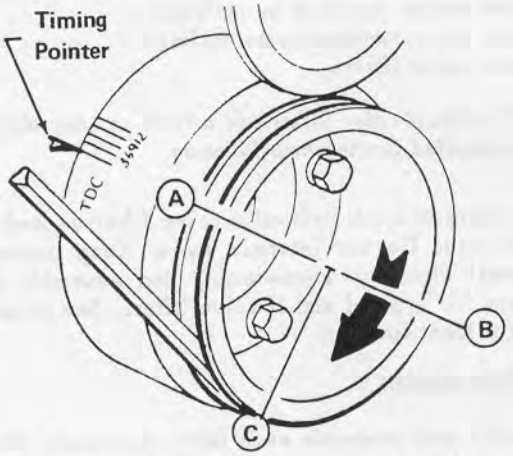

Figure 2. Position of Crankshaft for Checking Valve Clearance

POSITION "A"

With No. 1 piston on TDC at end of compression stroke (position "A" in Figure 2), check the following valves on 302 and 351 cu. in. engines:

a. No. 1 intake, No. 1 exhaust
b. No. 4 intake, No. 3 exhaust
c. No. 8 intake, No. 7 exhaust

POSITION "B"

Rotate crankshaft to position "B" in Figure 2 and check the following valves on 302 and 351 cu. in. engines:

a. No. 3 intake, No. 2 exhaust
b. No. 7 intake, No. 6 exhaust

POSITION "C"

Rotate crankshaft to position "C" in Figure 4 and check the following vlaves on 302 and 351 cu. in. engines:

a. No. 2 intake, No. 4 exhaust
b. No. 5 intake, No. 5 exhaust
c. No. 6 intake, No. 8 exhaust

2. Apply pressure on valve lifter with Tool 6513AC (Figure 3) to slowly bleed lifter until plunger is completely bottomed.
3. Hold valve lifter in full collapsed position and check available clearance with feeler gauge between rocker arm and valve stem tip. (Figure 3) Feeler gauge width must not exceed 3/8" (9.5mm). Clearance should be .083" to .183" (2.1mm to 4.6mm). Parts must be replaced if worn beyond specification.
4. Rotate crankshaft 180° (to position "B") clockwise from position "A". Repeat Steps 2 and 3 on appropriate valves.
5. Rotate crankshaft 270° (to position "C") clockwise from position "B". Repeat Steps 2 and 3 on appropriate valves.

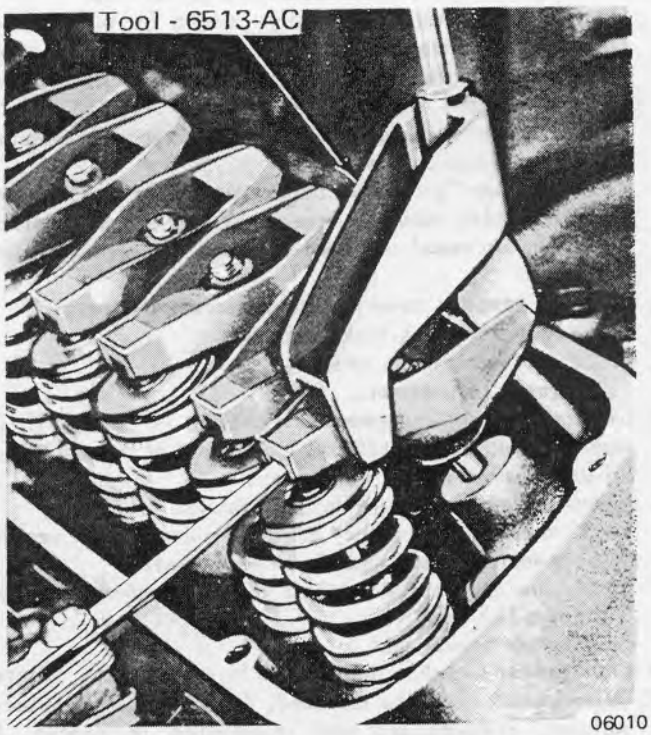

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Figure 3. Checking Valve Clearance

VALVE MECHANISM

REMOVAL

1. Remove rocker arm cover(s) as outlined.
2. Remove rocker arm stud nut, ball unit and rocker arm.

NOTE: Keep all parts in order when removed (to reinstall in same location).

3. Remove push rod(s) and identify (to reinstall in same location.

CLEANING

Clean all parts thoroughly. Make sure that all oil passages are open. Be certain that oil passage in push rod end of rocker arm is open.

INSPECTION

Check rocker arm pad, side rails and ball seat for excessive wear, cracks, nicks or burrs. Check rocker arm stud and nut for stripped or broken threads. Check ends of push rods for nicks, grooves, roughness or excessive wear. Check push rods visually for straightness while they are installed in engine by rotating rods with valve closed. Push rods also can be checked with a dial indicator.

INSTALLATION

1. Apply molycote to top of valve stem and ball units.
2. Install rocker arm ball unit and stud nut.
3. Install rocker arm cover(s) as outlined, preceding.

HYDRAULIC VALVE LIFTERS

Hydraulic valve lifters require little attention. Lifters are extremely simple in design, readjustments are not necessary and servicing requires only that care and cleanliness are exercised in the handling of parts.

LOCATING NOISY LIFTERS

Locate a noisy valve lifter by using a piece of garden hose approximately 4 ft. (1.2m) in length. Place one end of hose near end of each intake and exhaust valve, with other end of hose to the ear. In this manner, the sound is localized, making it easy to determine which lifter is at fault.

Another method is to place a finger on face of valve spring retainer. If lifter is not functioning properly, a distinct shock will be felt when valve returns to its seat.

General types of valve lifter noise are as follows:

1. Hard rapping noise -- Usually caused by plunger becoming tight in bore of lifter body so that return spring cannot push plunger back up to working position. Probable causes are:
   a. Excessive varnish or carbon deposit, causing abnormal stickiness.
   b. Galling or "pick-up" between plunger and bore of lifter body, usually caused by an abrasive piece of dirt or metal wedged between plunger and lifter body.
2. Moderate rapping noise -- Probable causes are:
   a. Excessively high leakdown rate.
   b. Leaky check valve seat.
   c. Improper adjustment.
3. General noise throughout valve train -- This will, in most cases, be a definite indication of insufficient oil supply or improper adjustment.
4. Intermittent clicking -- Probable causes are:
   a. A microscopic piece of dirt momentarily caught between ball seat and check valve ball.
   b. In rare cases, ball itself may be out-of-round or have a flat spot.
   c. Improper adjustment.

In most cases, where noise exists in one or more lifters, all lifter units should be removed, disassembled, cleaned in solvent, reassembled and reinstalled in engine. If dirt, corrosion, carbon, etc, is shown to exist in one unit, it more likely exists in all the units, thus it would only be a matter of time before all lifters caused trouble.

REMOVAL

1. Remove intake manifold as outlined.
2. Remove valve mechanism as outlined.
3. Remove valve lifters.

NOTE: Place valve lifters in a rack so that they may be reinstalled in the same location.

Internal parts of each hydraulic valve lifter assembly are matched sets. Do not intermix parts. Keep assemblies intact until cleaning. Disassembly and assembly procedures vary for Types I and II valve lifters. See respective figures for identification.

TYPE I DISASSEMBLY

Disassemble and assemble each lifter separately. Identify lifter assemblies so that they will be reinstalled in original bores.

1. Grasp lock ring with needle-nose pliers to release ring from groove. It may be necessary to depress plunger to fully release lock ring.
2. Remove push rod cup, metering valve (disc), plunger and spring.
3. Remove plunger assembly, check valve and check valve retainer and plunger spring. Carefully remove plunger spring, check valve retainer and check valve disc from plunger.

TYPE I ASSEMBLY (Figure 3A)

1. Place plunger upside down.
2. Place check valve (disc or ball check) in position over oil hole on bottom of plunger. Set check valve spring on top of check valve (disc or ball check).
3. Position check valve retainer over check valve and spring and push retainer down into place on plunger.

4. Place plunger spring and plunger (open end up) into lifter body.
5. Position metering valve (disc) in plunger, then place push rod cup in plunger.
6. Depress plunger and position closed end of lock ring in groove of lifter body. With plunger still depressed, position open ends of lock ring in groove. Release plunger, then depress it again to fully seat lock ring.

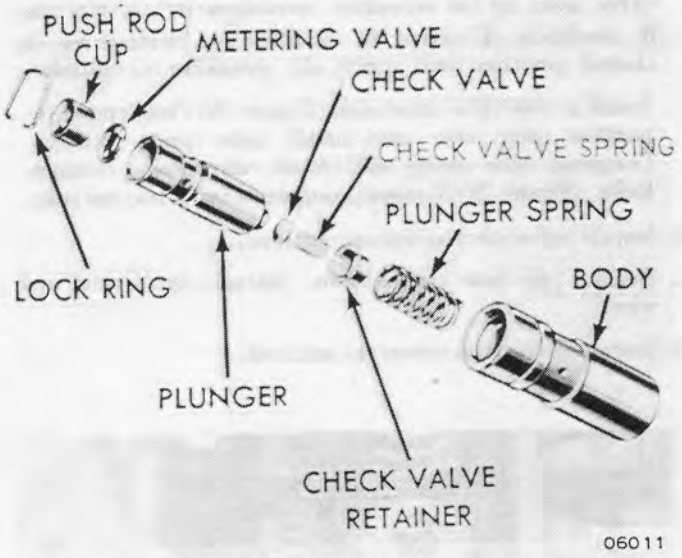

Figure 3A. Type I Hydraulic Valve Lifter Assembly

TYPE II DISASSEMBLY

Each valve lifter is a matched assembly. If parts of one lifter are intermixed with parts of another, improper valve operation may result. Disassemble and assemble each lifter separately. Keep lifter assemblies in proper sequence so that they will be reinstalled in original bores.

1. Grasp lock ring with needle-nose pliers to release ring from groove. It may be necessary to depress plunger to fully release lock ring.
2. Remove push rod cup, metering valve disc and upper metering valve. Do not bend metering valve or valve tensioning finger.
3. Remove plunger assembly, check valve and check valve retainer and plunger spring. Carefully remove plunger spring, check valve retainer and check valve disc from plunger.

TYPE II ASSEMBLY (Figure 3B)

1. Place plunger in an inverted position and center check valve disc on plunger. Carefully slide check valve over disc and down until valve bottoms. A slight turning motion will help. Use every precaution not to distort valve in any way, nor to bend preformed fingers. With slight turning motion, slide plunger spring over metering valve and down until spring seats.
2. Leaving assembly inverted, slide lifter body down over spring until body slightly compresses spring.
3. Place combined assembly right-side-up on work surface.
4. Position upper metering valve in plunger, taking care not to tilt it to either side and not to damage or bend valve tensioning finger. Place metering valve disc over metering valve and install push rod cup. Depress cup and install lock ring.

CLEANING

Thoroughly clean all parts in cleaning solvent and wipe them with a clean, lint-free cloth.

INSPECTION

1. Inspect parts and discard entire lifter assembly if any part shows pitting, scoring, galling, excessive wear or evidence or non-rotation.
2. Replace entire assembly, if plunger is not free in body. Plunger should drop to bottom of body by its own weight when assembled dry.
3. Assemble lifter assembly and check for freedom of operation by pressing down on push rod cup.

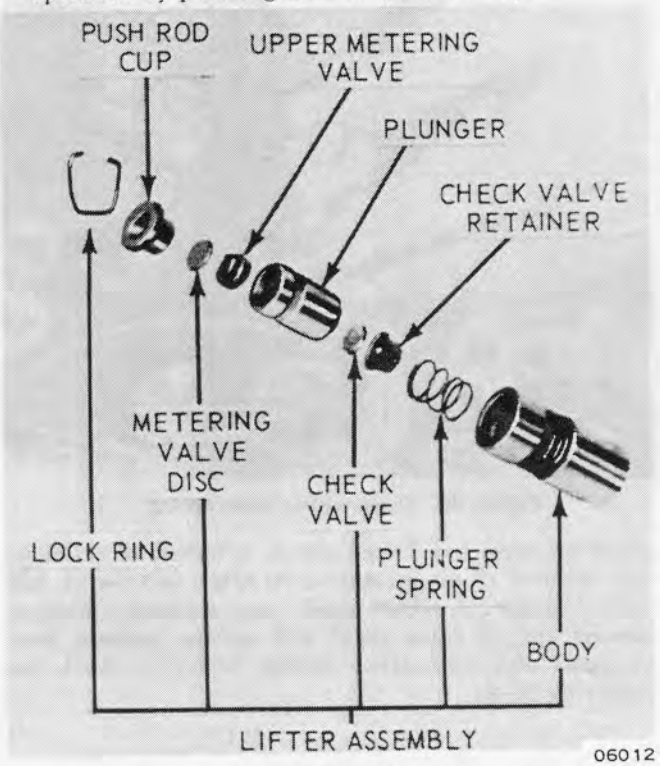

Figure 3B. Type II Hydraulic Valve Lifter Assembly

INSTALLATION

1. Install valve lifters.

   NOTE: Whenever new valve lifters are being installed, coat foot of valve lifters with molykote or equivalent.

2. Install intake manifold as outlined.
3. Install and adjust valve mechanism as outlined.

VALVE SPRING, RETAINER and STEM SEAL REPLACEMENT

Broken valve springs or damaged valve stem seals and retainers may be replaced without removing cylinder head if no damage to valve or valve seat.

1. Remove valve rocker arm cover and corresponding spark plug.
2. Remove valve rocker arm stud nuts, ball units, valve rocker arms and push rods from applicable cylinder.
3. Install an air line with adaptor in spark plug hole and turn on air.
4. Install stud nut and position compressor tool as shown in Figure 3D. Compress valve spring and remove retainer locks, spring retainer and valve spring.
5. Remove and discard valve stem seal.

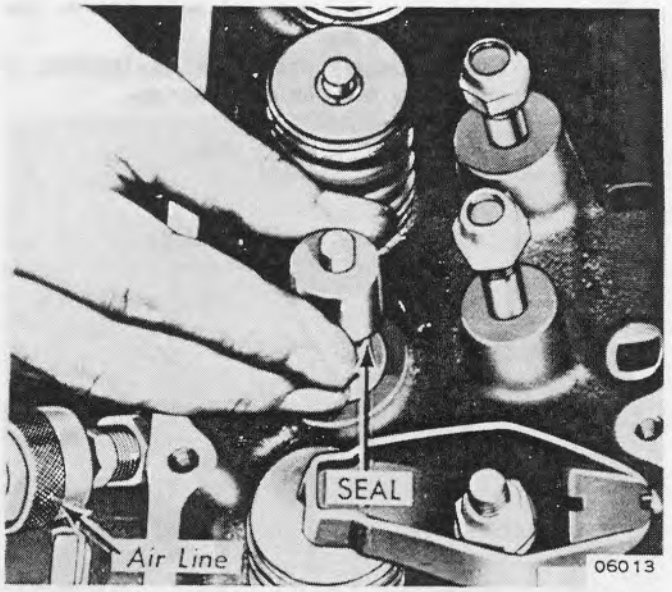

Figure 3C. Compressing Valve Spring

6. If air pressure has forced piston to bottom of cylinder, any removal of air pressure will allow valve(s) to fall into cylinder. A rubber band, tape or string (wrapped around end of valve stem) will prevent valve(s) from dropping and still allow enough travel to check the valve for binds. Move valve up and down thru normal travel in valve guide and check stem for binds. If valve has been damaged, remove cylinder head for repairs as outlined, following.
7. Inspect valve stem for damage. Rotate valve and check valve stem tip for eccentric movement during rotation.
8. If condition of valve is satisfactory, hold valve in closed position and apply air pressure to cylinder.
9. Install a new valve stem seal. (Figure 3C) Place spring in position over valve and install valve spring retainer. Compress valve spring and install valve spring retainer locks. (Figure 3D) Remove compressor tool and stud nut.
10. Install valve mechanism as outlined.
11. Remove air line and adaptor. Install spark plug and wire.
12. Install rocker arm cover as outlined.

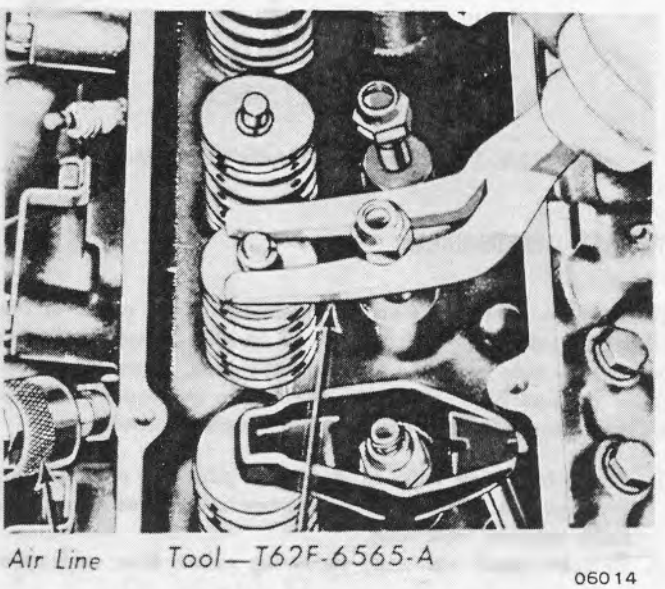

Figure 3D. Removing or Installing Valve Stem Seal

CYLINDER HEAD

If replacing a cylinder head, follow procedures under "Cylinder Head Disassembly and Assembly", following, and transfer all valves, springs, spark plugs, etc, to new cylinder head. Clean and inspect all parts, reface valves and check all assembly clearances before assembling new or used parts to new cylinder head.

REMOVAL

1. Remove intake manifold as outlined.
2. Remove exhaust manifold(s).
3. Remove rocker arm cover(s) as outlined.
4. Loosen distributor cap and remove spark plug wire hold-down. Remove plug wires and distributor cap as an assembly.
5. Remove spark plugs.
6. Remove valve mechanism as outlined.
7. Remove cylinder head attaching bolts and lift cylinder head off block.

DISASSEMBLY

1. Clean carbon out of cylinder head combustion chambers before removing valves.
2. Compress valve springs. (Figure 3D) Remove spring retainer locks and release spring.
3. Remove spring retainer, spring, stem seal and valve. Discard valve stem seals. Identify all valve parts.
4. Clean, inspect and repair cylinder head, as required, or transfer all usable parts to a new cylinder head.

CLEANING

1. With valves installed to protect valve seats, remove deposits from combustion chambers and valve heads with a scraper and wire brush. Be careful not to damage cylinder head gasket surface.
2. After removing valves, clean valve guide bores with a valve guide cleaning tool. Use cleaning solvent to remove dirt, grease and other deposits.
3. Clean all bolt holes and remove all deposits from valves with a fine brush or buffing wheel.

INSPECTION

Check cylinder head for cracks and inspect gasket surface for burrs and nicks. Replace head if cracked.

CYLINDER HEAD FLATNESS

When a cylinder head is removed because of gasket leaks, check cylinder head for flat gasket surface according to specifications. (Figure 4) If necessary to refinish cylinder head gasket surface, do not plane or grind off more than .010" (.25mm).

Figure 4. Typical Cylinder Head Flatness

VALVE SEAT RUNOUT

Check valve seat runout with accurate gauge. (Figure 5) Follow instructions of gauge manufacturer. If runout exceeds wear limit, reface valve and valve seat.

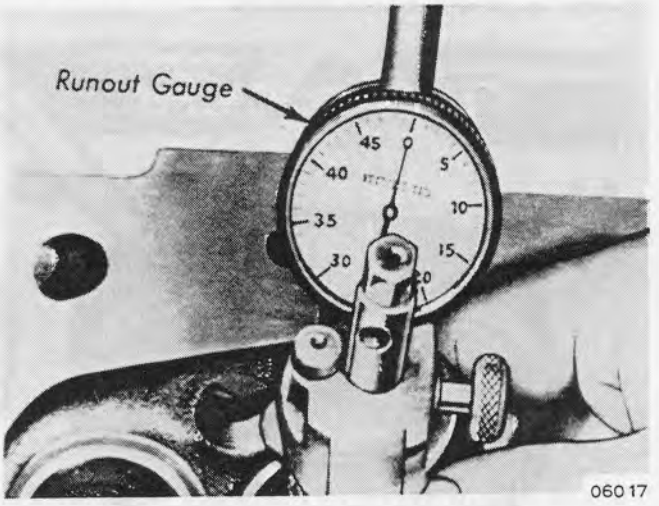

Figure 5. Checking Valve Seat Runout

VALVE INSPECTION

1. The critical inspection points and tolerances of valves are illustrated in Figure 6. Refer to specifications for wear limits.
2. Inspect valve face and edge of valve head for pits, grooves, scores or other damage.
3. Inspect stem for bent condition and end of valve head for pits, grooves, scores or other wear.
4. Inspect stem for bent condition and end of stem for grooves or scores.
5. Check valve head for signs of burning, erosion, warping and cracking. Minor pits, grooves, etc, may be removed. Discard valves that are severely damaged.
6. Inspect valve spring, valve spring retainers, locks and sleeves for wear or damage. Discard any visually damaged parts.

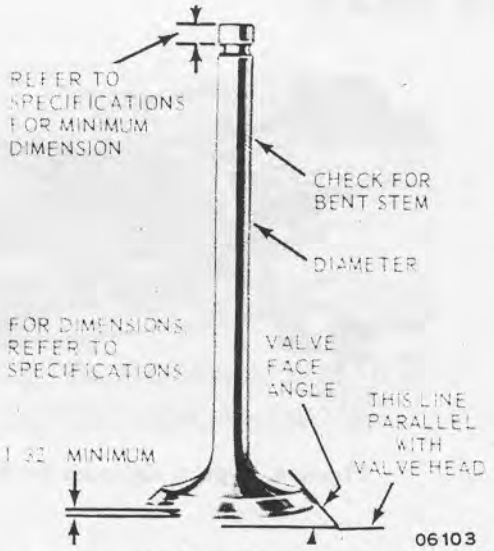

Figure 6. Critical Valve Dimensions

VALVE SEAT WIDTH

Measure valve seat width. (Figure 7) Reface valve seats if width is not within specifications.

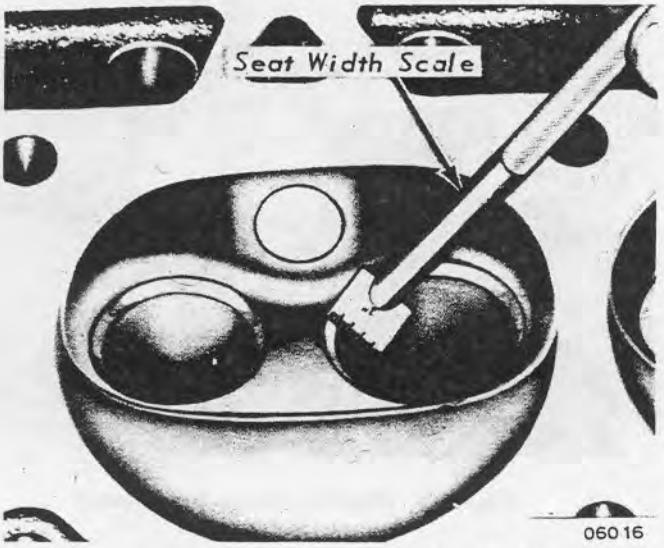

Figure 7. Checking Valve Seat Width

VALVE STEM CLEARANCE

1. Measure valve stem clearance (Figure 8) as follows: Clamp a dial indicator on one side of cylinder head rocker arm cover gasket rail, locating indicator so that movement of valve stem from side to side (crosswise to the head) will cause a direct movement of indicator stem. Indicator stem must contact side of valve stem just above valve guide.
2. With valve head dropped about 1/16" (1.6mm) off valve seat, move valve stem from side-to-side, using light pressure to obtain a clearance reading.

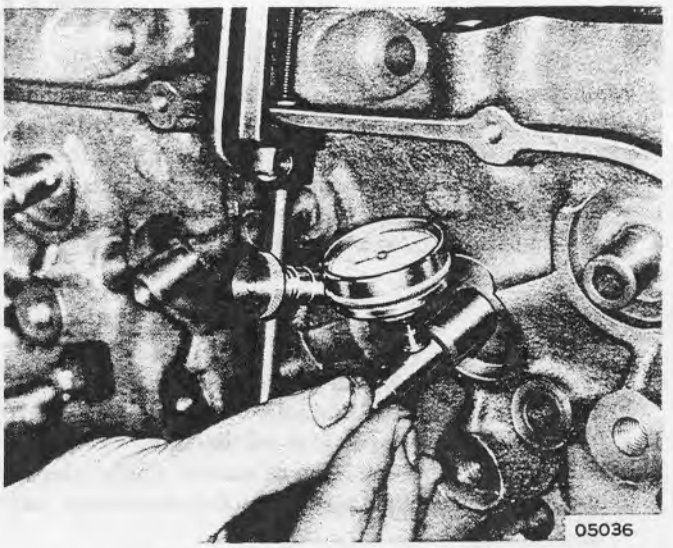

Figure 8. Checking Valve Stem Clearance

3. If clearance exceeds specifications, it will be necessary to ream valve guides for oversize valves, as outlined.

VALVE SPRING PRESSURE

1. Check springs for correct pressure at specified spring lengths with Tool J-8056. (Figure 9)

   IMPORTANT: DO NOT manually rotate valve spring assemblies while installed in engine to determine good and/or bad valve springs. Weak valve springs cause poor engine performance.

2. Replace any spring not within specifications.

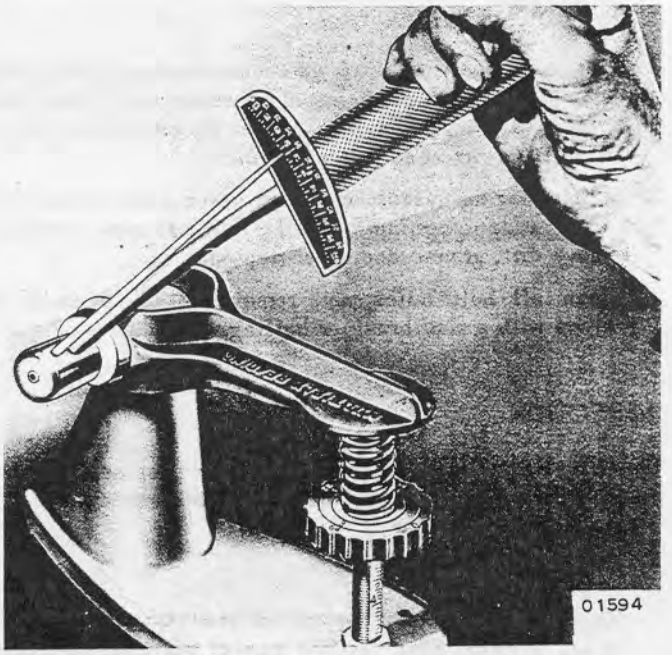

Figure 9. Checking Valve Spring Pressure

VALVE SPRING "SQUARE"

1. Check each spring for "square" with a steel square and flat surface. (Figure 10)
2. Stand spring and square on end on flat surface. Slide spring up to square.
3. Revolve spring slowly and observe space between top coil of spring and square. Out-of-square limits are 5/16" (8mm).
4. Follow same procedure to check new valve springs before installation.

IMPORTANT: Make certain that proper spring (color coded) is installed.

5. Visually inspect valve spring retainer to determine if damper spring coil has been hitting retainer. This interference also will cause a clicking noise when engine is operating. Damper spring is properly installed in valve spring when positioned so that end of damper spring bottom coil is 135° counterclockwise from end of valve spring lower coil.

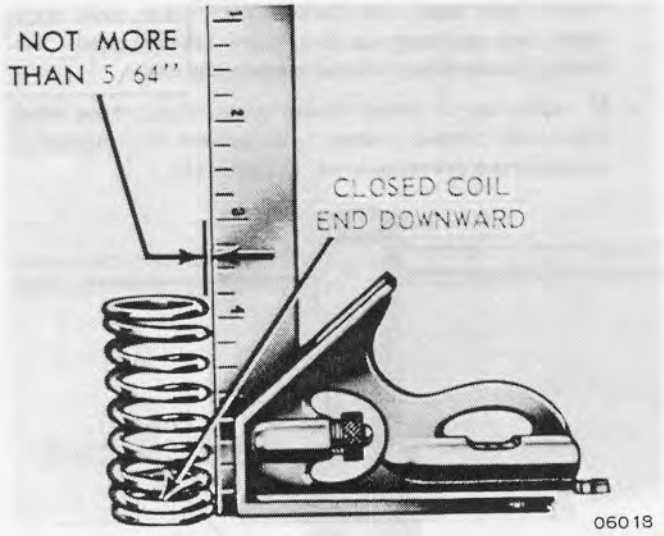

Figure 10. Checking Valve Spring Squareness

REAMING VALVE GUIDES

1. If valve stem to valve guide clearance exceeds the wear limit, ream valve guide for next oversize valve stem (.015" [.38mm] available).
2. Use Reaming Kit T526-6085-AEE when reaming a valve guide (Figure 11) to install valve with oversize stem. Kit has .003" (.075mm) OS reamer with standard diameter pilot and .015" OS reamer with .003" OS pilot.
3. When going from standard size valve to oversize valve, always use reamer in sequence.
   IMPORTANT: Always reface valve seat after valve guide has been reamed and use a suitable scraper to break the sharp corner (ID) at top of valve guide.

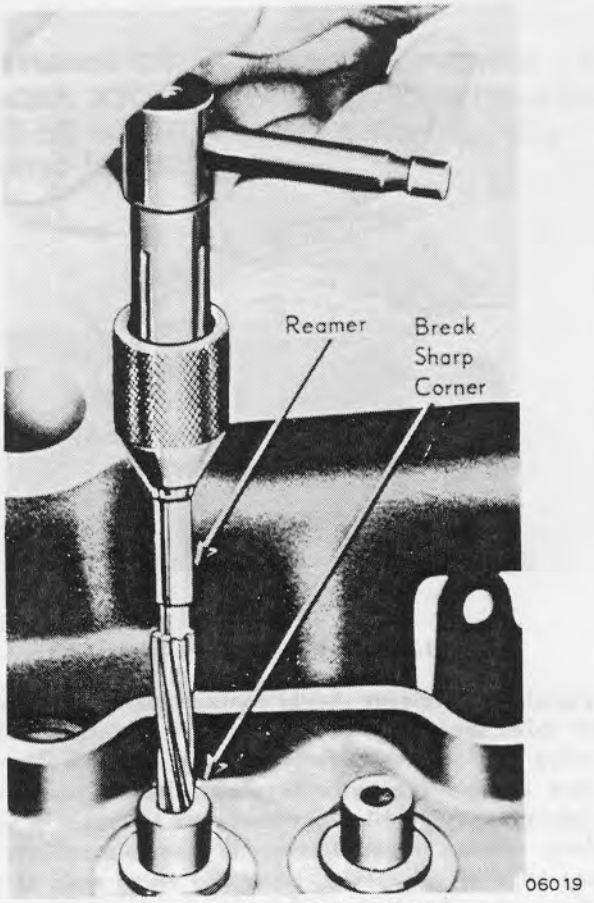

Figure 11. Reaming Valve Guides

REFACING VALVE SEATS

1. Closely coordinate refacing valve seat with refacing valve face so that finished seat and valve face are concentric, and specified interference fit will be maintained. This is important so that valve and seat have a compression-tight fit. Be sure that refacer grinding wheels are properly dressed.

2. Grind valve seats to a true 45° angle. (Figure 12) Remove only enough stock to clean up pits and grooves or to correct valve seat runout. After seat has been refaced, use a seat width scale or a machinist scale to measure seat width. (Figure 12) Narrow seat, if necessary, to meet specifications.

3. If valve seat width exceeds maximum limit, remove enough stock from top edge and/or bottom edge of seat to reduce width to specifications.

4. On valve seats of all engines, use a 60° angle grinding wheel to remove stock from bottom of seats (raise seats) and use a 30° angle wheel to remove stock from top of seats (lower seats).

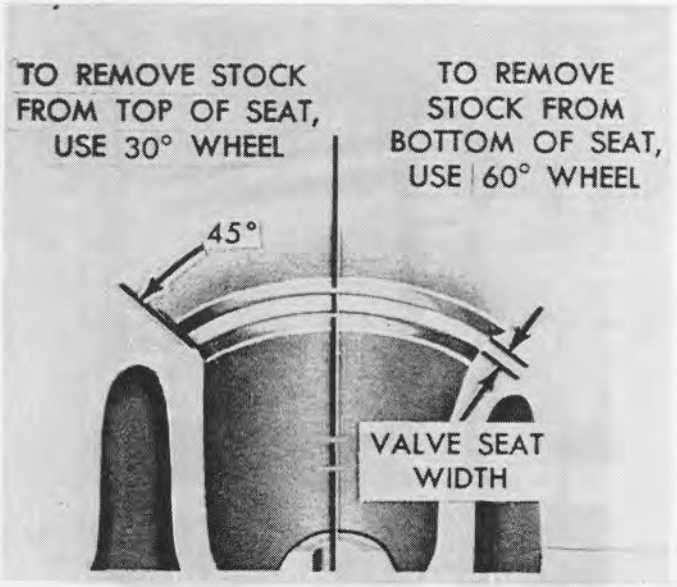

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Figure 12. Refacing Valve Seat

5. Finished valve seat should contact approximate center of valve face. It is good practice to determine where valve seat contacts face by coating seat with Prussian blue and setting valve in place. Rotate valve with light pressure. If blue is transferred to center of valve face, contact is satisfactory. If blue is transferred to top edge of valve face, lower the valve seat. If blue is transferred to bottom edge of valve face, raise valve seat.

ROCKER ARM STUD REPLACEMENT

1. If necessary to remove a rocker arm stud, use Tool Kit T62F-6A527-B which contains a stud remover, a .006" (.15mm) oversize reamer and a .015" (.38mm) oversize reamer.
2. To press in replacement studs, use Stud Replacer T69P-6049-D.

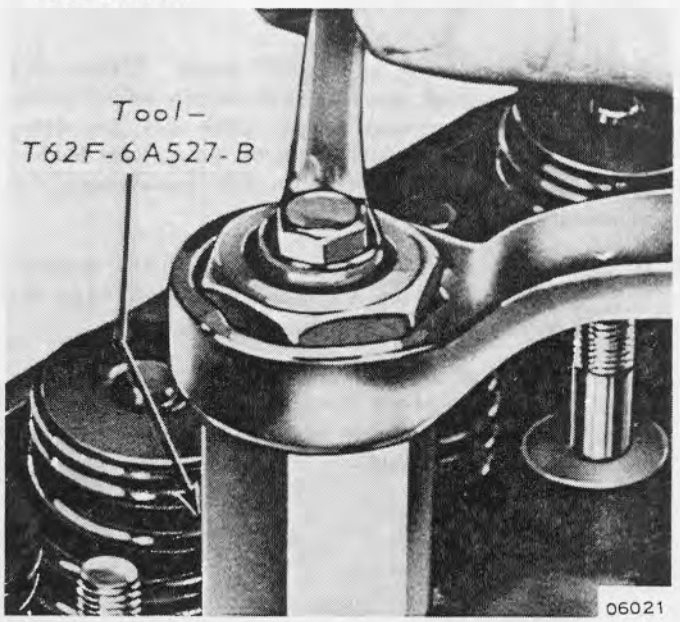

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Figure 13. Removing Rocker Arm Stud

3. Broken or rocker arm studs with damaged threads may be replaced with standard studs.
4. Replace loose studs in head with .006" or .015" oversize studs which are available for service.
5. Identify standard and oversize studs by measuring stud diameter within 1-1/8" (28.6mm) from pilot end of stud. Stud diameters are:

   Standard : .3714"-.3721"
   .006" Oversize: .3774"-.7781"
   .015" Oversize: .3864"-.3871"

6. When going from standard-size rocker arm stud to .015" oversize stud, always use .006" oversize reamer before finish-reaming with .015" oversize reamer.

   NOTE: Cut off threaded part of stud to permit correct tool remover installation.

   a. Position sleeve of rocker arm stud Remover Tool T62F-6A527-B over stud with bearing end down. Thread puller into sleeve and over stud until fully bottomed. Hold puller with wrench, then rotate sleeve clockwise to remove stud. (Figure 13) If rocker arm stud was broken off flush with stud boss, use an easy-out to remove broken stud, following instructions of tool manufacturer.

   b. If replacing a loose rocker arm stud, ream stud bore with correct reamer (or reamers in sequence) for selected oversize stud. (Figure 14)

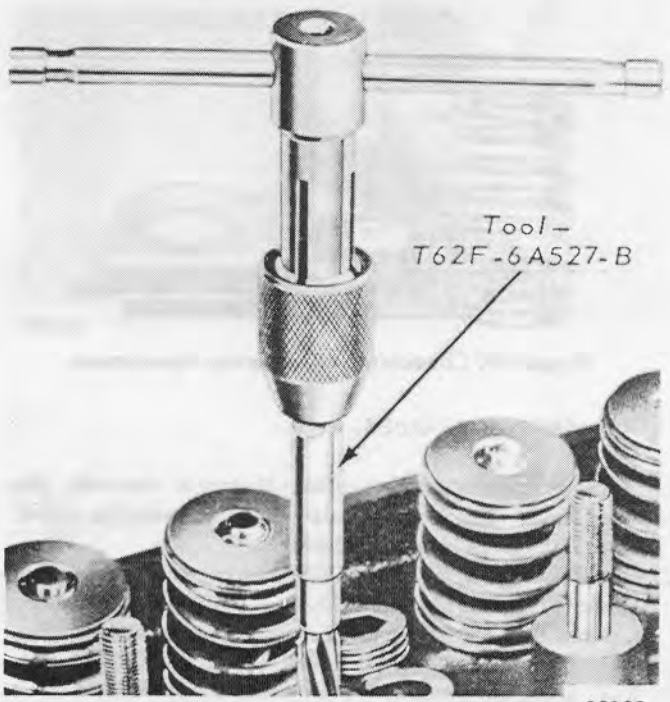

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Figure 14. Reaming Rocker Arm Stud Bore

IMPORTANT: Make certain that metal particles DO NOT ENTER valve area.

   c. Use Tool T69P-6049-D when installing stud. (Figure 15)

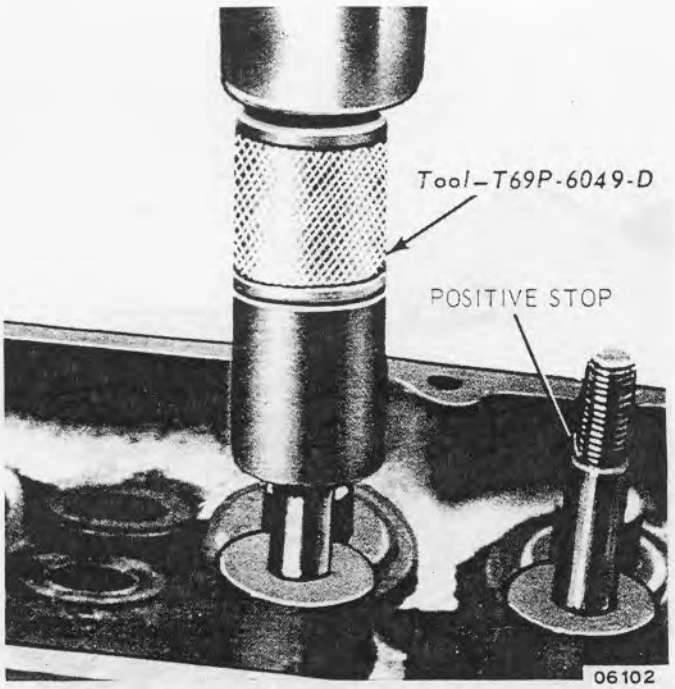

Figure 15. Installing Stud

VALVES

1. Minor pits, grooves, etc, may be removed. Discard severely damaged valves, or if face runout or stem clearance exceeds specifications.
2. Discard any worn or damaged valve train parts.

REFACING VALVES

1. Closely coordinate valve refacing operation with valve seat refacing operations so that finished angles of valve face and of valve seat will meet specifications and provide a compression-tight fit. Be sure that refacer grinding wheels are properly dressed.
2. If valve face runout is excessive and/or to remove pits and grooves, reface valves to a true 44° angle. Remove only enough stock to correct runout or to clean up pits and grooves. If edge of valve head is less than 1/32" (.8mm) thick after grinding, replace valve, as valve will run too hot in engine. Interference fit of valve and seat should not be lapped out.
3. Remove all grooves or score marks from end of valve stem and chamfer it as necessary. Do not remove more than .010" (.25mm) from end of the valve stem. Valve stem from valve lock groove to end (Figure 7, preceding) must not be shorter than minimum specified length.
4. If valve and/or valve seat has been refaced, it will be necessary to check clearance between rocker arm pad and valve stem with valve train assembly installed in engine.

ASSEMBLY

1. Install each valve in port from which it was removed or to which it was fitted. Install a new stem seal on valve.
2. Install valve spring over the valve, then install spring retainer. Compress spring and install retainer locks. (Figure 16)
3. Measure assembled height of valve spring from surface of cylinder head spring pad to underside of spring retainer with dividers.(Figure 17)Check dividers against a scale. If assembled height is greater than specifications, install .030" (.76mm) thick spacer(s), as required, between cylinder head spring pad and valve spring for correct height.

IMPORTANT: Do not install spacers unless necessary. Spacers in excess of recommendations will overstress valve springs and overload camshaft lobes which could lead to spring breakage and/or worn camshaft lobes.

INSTALLATION

1. Clean all gasket surfaces to obtain flat, smooth cylinder head and block mating.
2. Position new cylinder head gasket over cylinder head dowels on block. Position cylinder head on block and install attaching bolts.
3. Cylinder head bolts are tightened in 3 Progressive steps. Torque all bolts in sequence and finally to specifications. (Figure 18) When head bolts have been tightened, following this procedure, it is not necessary to retorque bolts after extended operation. Bolts may be checked, however, and retorqued, if desired.

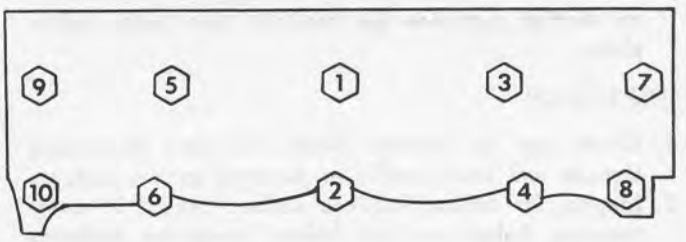

Figure 18. Cylinder Head Bolt Torque Sequence

4. Install valve mechanism as outlined, preceding.
5. Install rocker arm cover(s) as described previously.
6. Install intake manifold as outlined, preceding.
7. Install exhaust manifolds as described previously.

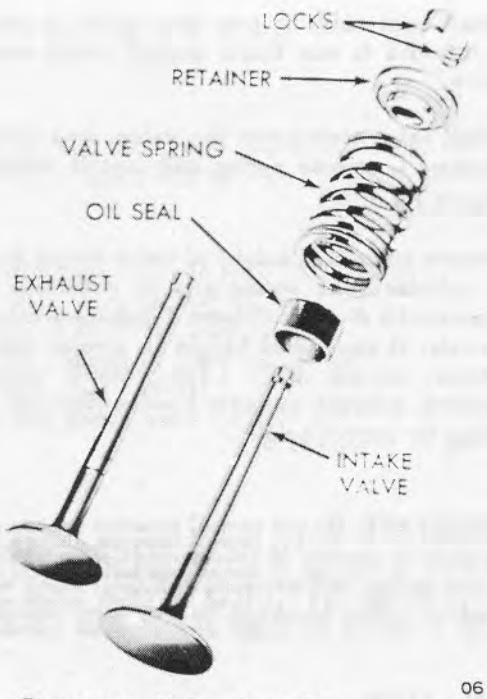

Figure 16 . Valve Assembly

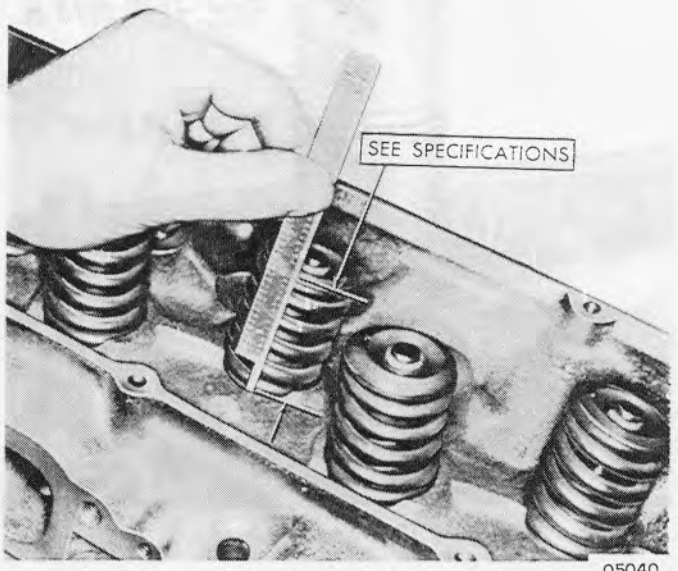

Figure 17. Measuring Spring Height

OIL PAN

REMOVAL

1. Drain crankcase. Remove oil level dipstick and tube.
2. Remove seawater pump adjustment bracket.
3. Remove attaching screws and washers and remove oil pan.

CLEANING

1. Scrape any dirt or metal particles from inside of pan.
2. Scrape all old gasket material from gasket surface.
3. Wash pan in solvent and dry thoroughly. Be sure that all foreign particles are removed from below baffle plate.

INSPECTION

1. Check pan for cracks, holes, damaged drain plug threads and loose baffle or damaged gasket surface.
2. Inspect for damage (uneven surface caused by over-torquing bolts) at bolt holes. Straighten surfaces as required.
3. Repair any damage or replace pan if repairs cannot be made.

INSTALLATION

1. Before installing aluminum oil pan, coat surfaces of front and rear oil pan seals (Figure 1) with Oil Pan Sealant (C-92-52238-1).
2. Clean gasket surfaces of block and oil pan. Oil pan has a 2-piece gasket. Coat block surface and oil pan gasket with sealer. Position oil pan gaskets on cylinder block.
3. Position oil pan front seal on cylinder front cover.
4. Position oil pan rear seal on rear main bearing cap. (Figure 1) Be sure that tabs on seals are over oil pan gasket.
5. Install oil pan bolts, torquing to specifications from center outward in each direction.
6. Install oil level dipstick. Fill crankcase with correct grade and quantity of engine oil. Start engine and check for oil leaks.

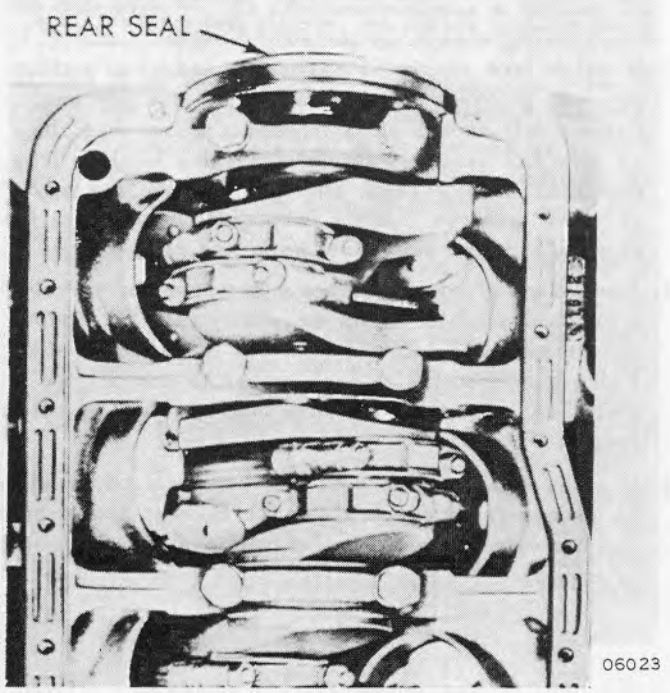

Figure 1. Oil Pan Gaskets and Seals Installed

OIL PUMP

REMOVAL

1. Remove oil pan as outlined, preceding.
2. Remove oil pump inlet tube and screen assembly.
3. Remove oil pump attaching bolts and remove oil pump, gasket and intermediate drive shaft.

DISASSEMBLY

1. Remove oil inlet tube from oil pump and remove gasket.
2. Remove cover attaching screws and cover. Remove inner rotor and shaft assembly, then remove outer race.
3. Insert a self-threading sheet metal screw of proper diameter into oil pressure relief valve chamber cap and pull cap out of chamber. Remove spring and plunger.

CLEANING

1. Wash all parts in a solvent and dry them thoroughly with compressed air.
2. Clean inside of pump housing and pressure relief valve chamber with a brush. Be sure that all dirt and metal particles are removed.

INSPECTION

1. Refer to specifications for clearances and wear limits.
2. Check inside of pump housing and outer race and rotor for damage or excessive wear.
3. Replace cover if cover mating surface is worn, scored or grooved.
4. Measure outer race to housing clearance. (Figure 2)

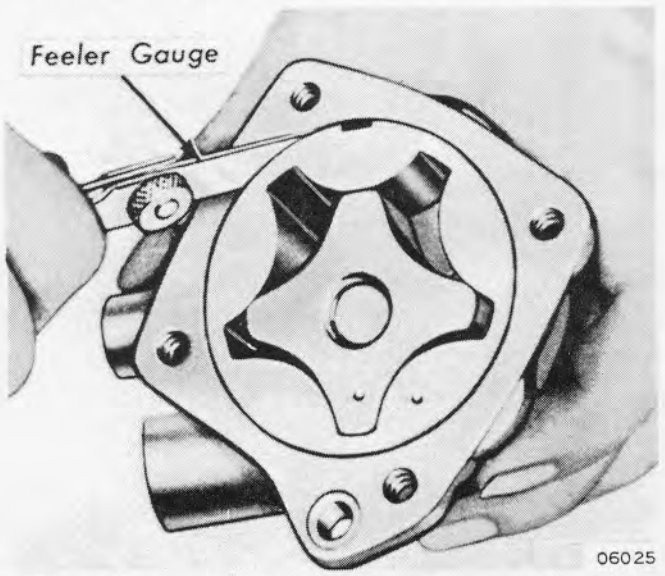

Figure 2. Checking Outer Race to Housing Clearance

5. With rotor assembly installed in housing, place a straight edge over rotor assembly and housing. Measure clearance (rotor end play) between straight edge and rotor and outer race. (Figure 3)

NOTE: Outer race, shaft and rotor are replaceable as an assembly.

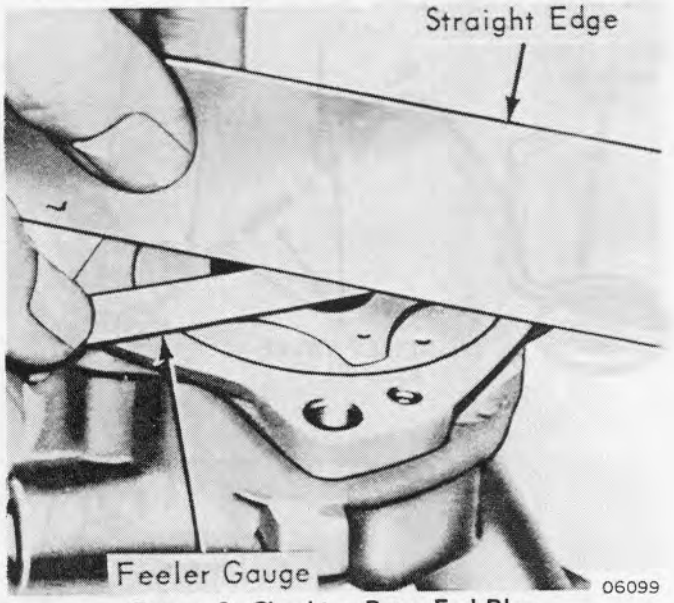

Figure 3. Checking Rotor End Play

6. Check drive shaft to housing bearing clearance by measuring OD of shaft and ID of housing bearing.
7. Inspect relief valve spring for collapsed or worn condition. Check relief valve spring tension. If spring tension is not within specifications, and/or spring is worn or damaged, replace spring.
8. Check relief valve piston for scores and free operation in bore.

ASSEMBLY

Oil pump assembly is shown in Figure 4.

1. Oil all parts thoroughly.
2. Install oil pressure relief valve plunger, spring and new cap.
3. Install outer race and inner rotor and shaft assembly. Be sure that dot (identification mark) on outer race is facing outward and on same side as identification mark on rotor. The race rotor and shaft and outer race are serviced as an assembly. Do not replace one part without replacing other.
4. Install cover and torque cover attaching screws to specifications.
5. Position new gasket and oil inlet tube on oil pump and install attaching bolts.

INSTALLATION

1. Prime oil pump by filling either inlet or outlet port with engine oil. Rotate pump shaft to distribute oil within pump body.
2. Position intermediate drive shaft into distributor socket. With shaft firmly seated in distributor socket, stop on shaft should touch roof of crankcase. Remove shaft and position stop as necessary.
3. Position new gasket on pump housing. With stop properly positioned, insert intermediate drive shaft into oil pump. Install pump and shaft as an assembly.

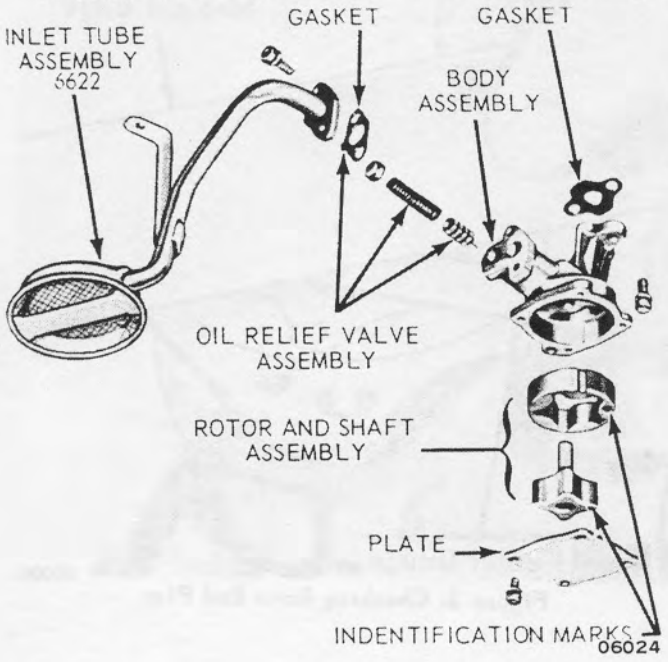

Figure 4. Oil Pump Assembly

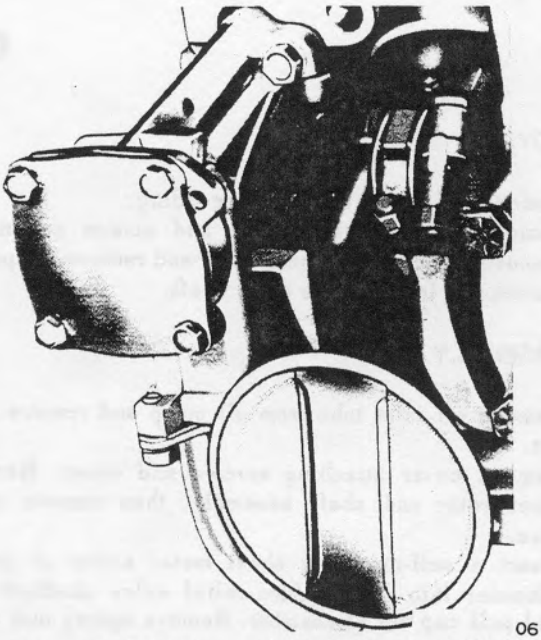

Figure 5. Oil Pump and Inlet Tube Installed

IMPORTANT: Do not attempt to force pump into position if it will not seat readily. Drive shaft hex may be misaligned with distributor shaft. To align, rotate intermediate drive shaft into a new position.

4. Torque oil pump attaching screws to specifications.
5. Clean and install oil pump inlet tube and screen assembly. (Figure 5)
6. Install oil pan and related parts as outlined under "Oil Pan Installation", preceding.

FLYWHEEL

REMOVAL

1. Remove transmission and oil cooler (if so equipped).
2. Remove solenoid bracket complete with solenoid, harness and trim indicator wires.
3. Remove flywheel cover and housing.
4. Remove drive plate or clutch and pressure plate from flywheel.
5. Remove flywheel attaching bolts and remove flywheel.

INSPECTION

1. Inspect flywheel for cracks, heat check or other damage that may make it unfit for further service. Machine friction surface of flywheel if surface is scored or worn. If necessary to remove more than .045" (1.14mm) of stock from original thickness, replace flywheel.
2. Inspect ring gear for worn, chipped or cracked teeth. If teeth are damaged, replace ring gear.
3. Install a dial indicator with indicator point pressing against flywheel face. (Figure 6) Turn flywheel and be sure that it is full forward or backward so that crankshaft end play will not be indicated as flywheel runout.
4. If clutch face runout exceeds specifications, remove flywheel and check for burrs between flywheel and face of crankshaft mounting flange. If no burrs exist, check runout of crankshaft mounting flange. Replace flywheel or machine crankshaft-flywheel mounting face sufficiently to true-up the surface. If mounting flange runout exceeds specifications, replace flange or reinstall it on flywheel.

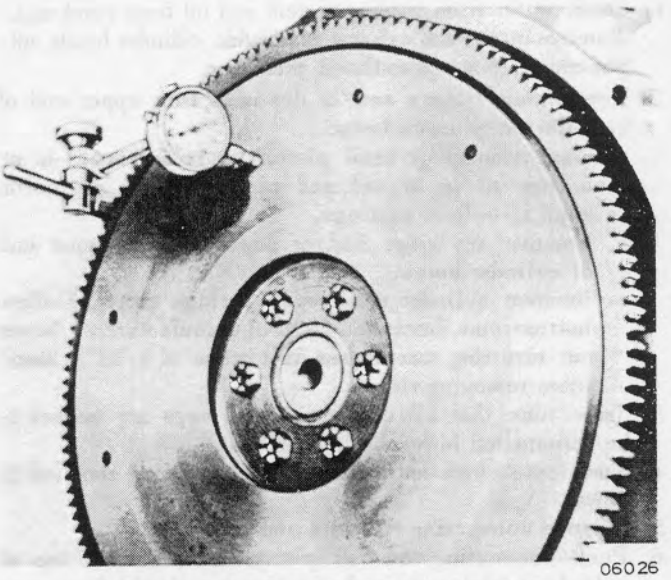

Figure 6. Checking Flywheel Face Runout

INSTALLATION

1. Coat threads of flywheel attaching bolts with oil resistant sealer. Position flywheel on crankshaft flange. Install and torque bolts in sequence across from each other.
2. Install drive plate or clutch and pressure plate. Align clutch plate (if used) with pilot bearing in flywheel.
3. Install flywheel housing and cover.
4. Install solenoid bracket complete with solenoid, harness and trim indicator wires.
5. Install transmission and oil cooler (if so equipped).

PISTONS AND CONNECTING RODS

REMOVAL

1. Drain water from cooling system and oil from crankcase. Remove intake and exhaust manifolds, cylinder heads, oil pan and oil pump as outlined, preceding.
2. Remove any ridges and/or deposits from upper end of cylinder bores as follows:
   a. Turn crankshaft until piston (to be removed) is at bottom of its travel and place a cloth on piston head to collect cuttings.
   b. Remove any ridge and/or deposits from upper end of cylinder bores.
   c. Remove cylinder ridge with a ridge cutter. Follow instructions furnished by tool manufacturers. Never cut into ring travel area in excess of 1/32" (.8mm) when removing ridges.
3. Make sure that all connecting rod caps are marked to be reinstalled in original positions.
4. Turn crankshaft until connecting rod being removed is down.
5. Remove connecting rod nuts and cap.
6. Push connecting rod and piston assembly out top of cylinder with handle end of a hammer. Avoid damage to crankshaft journal or cylinder wall when removing piston and rod.
7. Remove bearing inserts from connecting rod and cap.
8. Install cap on connecting rod from which it was removed.

DISASSEMBLY

1. Remove bearing inserts from connecting rod end cap.
2. Mark pistons and pins to assure reassembly on same rod and installation in same cylinders from which they were removed.
3. Remove piston rings. Using an arbor press and tool shown in Figure 1, press piston pin from piston and connecting rod.

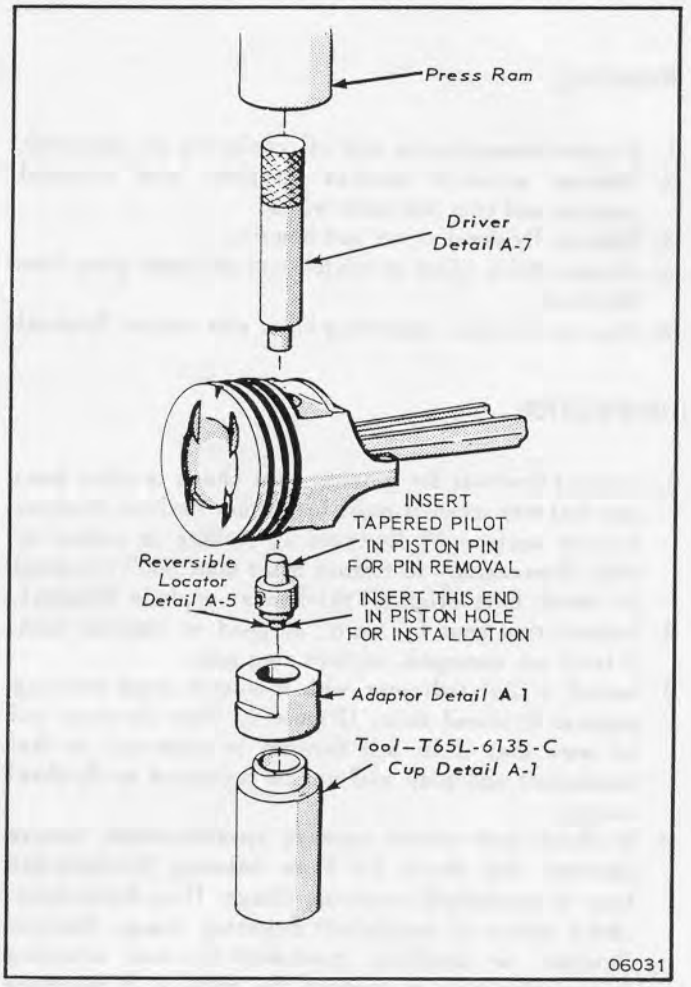

Figure 1. Removing or Installing Piston Pin

CONNECTING RODS

CLEANING

Remove bearings from rod and cap. Identify bearings if re-using. Clean connecting rod in solvent, including rod bore and back of inserts. DO NOT use a caustic cleaning solution. Blow out all passages with compressed air.

INSPECTION

Carefully inspect connecting rods and related parts to meet specifications. Various forms of engine wear, related to these parts, can be readily identified.

1. Shiny surface on pin boss side of piston usually indicates a bent connecting rod, or piston pin hole is not in proper relation to piston skirt and ring grooves.
2. Abnormal connecting rod bearing wear may be caused by either a bent connecting rod, an improperly machined crankpin or a tapered connecting rod bore.
3. Twisted connecting rods will not create a wear pattern easy to identify, but badly twisted rods will disturb action of entire piston, rings and connecting rod assembly and may cause excessive oil consumption.
4. Inspect connecting rods for signs of fractures and bearing bores for out-of-round and taper. If bore exceeds recommended limits and/or, if connecting rod is fractured, replace rod.
5. If wear is present in piston pin area, replace connecting rod.
6. Replace defective connecting rod nuts and bolts.
7. Check connecting rods for bend or twist on a suitable alignment fixture. Follow instructions of fixture manufacturer. If bend and/or twist exceeds specifications, straighten or replace connecting rod.

PISTONS, PINS AND RINGS

CLEANING

Remove deposits from piston surfaces. Clean gum or varnish from piston skirt, piston pins and rings with solvent. DO NOT use a caustic cleaning solution or a wire brush to clean pistons. Clean ring grooves with ring groove cleaner. (Figure 2) Make sure that oil ring slots (or holes) are clean.

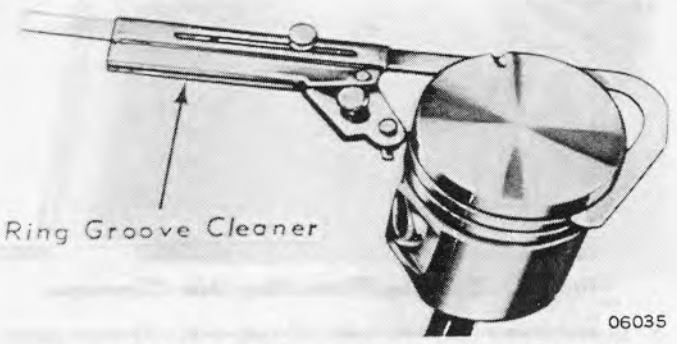

Figure 2. Cleaning Piston Ring Grooves--Typical

INSPECTION

1. Carefully inspect pistons for fractures at ring lands, skirts and pin bosses and for scuffed, rough or scored skirts. If lower inner portion of ring grooves has a high step, replace piston. The step will interfere with ring operation and cause excessive ring side clearance.
2. Spongy, eroded areas near edge of top of piston usually are caused by detonation or pre-ignition. A shiny surface on thrust surface of piston, offset from centerline between piston pin holes, may be caused by a bent connecting rod. Replace pistons which show signs of excessive wear, wavy ring lands or fractures or damage from detonation or pre-ignition.
3. Check piston to cylinder bore clearance by measuring piston and bore diameters. Refer to specifications for proper clearance. Refer to "Cylinder Block Inspection" preceding, for bore measurement procedure. Measure OD of piston with micrometers at centerline of piston pin bore and at 90° to pin bore axis. Check ring side clearance following procedure under "Fitting Piston Rings," preceding.
4. If wear is present in piston pin area, replace piston.
5. Replace all rings which are scored, chipped or cracked Check end gap and side clearance. DO NOT transfer rings from one piston to another.

ASSEMBLY

Piston, connecting rod and related parts are shown in Figure 3.

IMPORTANT: Check fit of a new piston in cylinder bore before assembling piston pin to connecting rod.

Piston pin bore of a connecting rod and diameter of piston pin must be within specifications.

1. Apply light coat of engine oil to all parts. Assemble piston to connecting rod with cylinder number side of connecting rod and indentation notch in piston positioned as shown in Figure 4. On replacement connecting rods, install large-chamfered side of connecting rod bearing bore toward crankshaft cheek, facing toward front of engine on right bank rods and facing toward rear of engine of left bank rods.
2. Start piston pin in piston and connecting rod (this may require a very light tap with a mallet). Using an arbor press, press piston pin thru piston and connecting rod until pin is centered in piston. (Figure 4)
3. Install piston rings.

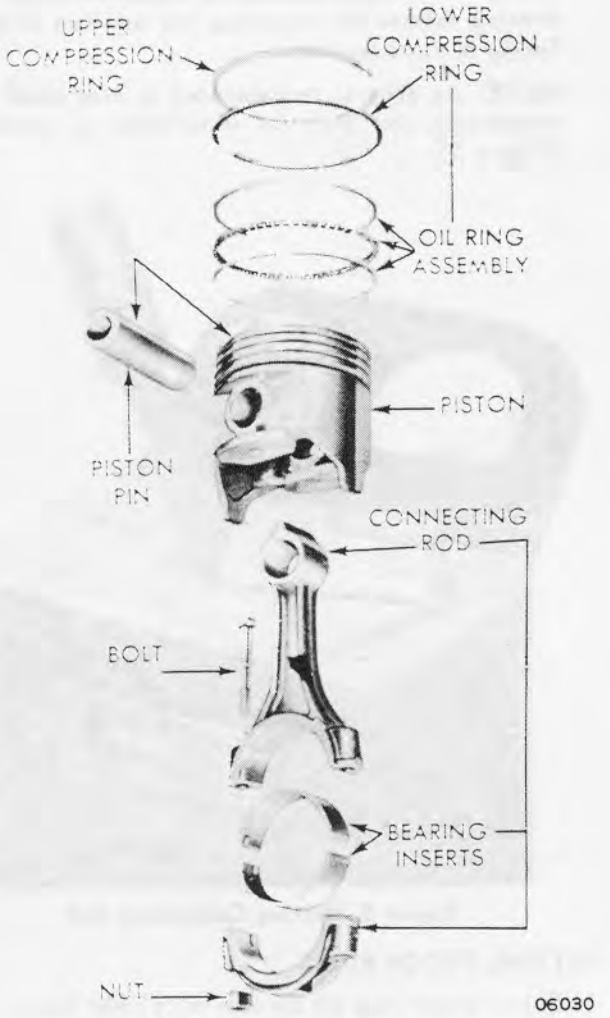

Figure 3. Piston, Connecting Rod and Related Parts

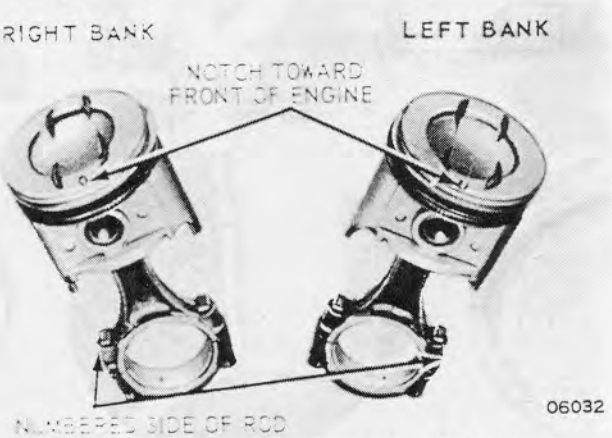

Figure 4. Correct Piston and Rod Positions

4. Be sure that bearing inserts and bearing bore in connecting rod and cap are clean. Foreign material under inserts will distort bearing and cause a failure. Install bearing inserts in connecting rod and cap with tangs fitting in slots provided.

   NOTE: An oven is recommended to heat small end of connecting rod prior to installation of piston pin. (Figure 5)

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Figure 5. Heating Connecting Rod

FITTING PISTON RINGS

1. Select proper ring set for size of cylinder bore.
2. Position ring in cylinder bore in which it is to be used.
3. Push ring down into bore area where normal ring wear is not encountered.
4. Use head of a piston to position ring in bore so that ring is square with cylinder wall. Use caution to avoid damage to ring or cylinder bore.

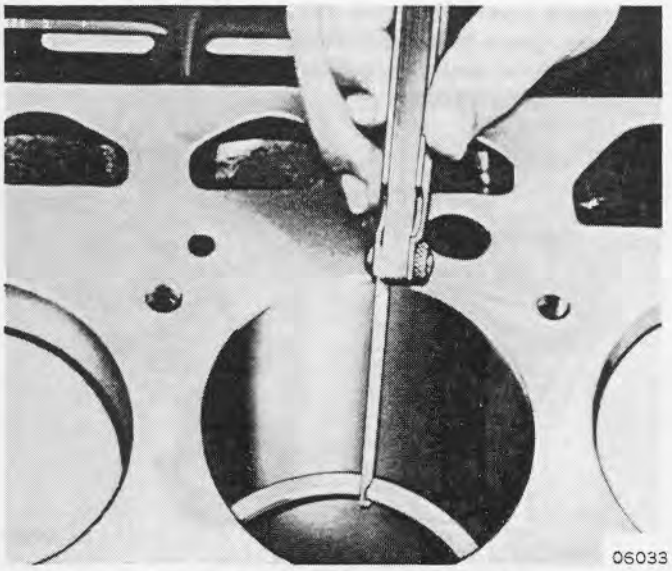
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Figure 6. Checking Piston Ring Gap

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Figure 7. Checking Piston Ring Side Clearance

5. Measure gap between ends of ring with a feeler gauge. (Figure 6) If ring gap is less or greater than specified limits, try another ring set.
6. Check ring side clearance of compression rings with a feeler gauge inserted between ring and its lower land. (Figure 7) Gauge should slide freely around entire ring circumference without binding. Wear forms a step at inner portion of lower land. If lower lands have high steps, replace piston.

INSTALLATION

1. If installing new piston rings, remove cylinder wall glaze. Follow instructions of tool manufacturer.
2. Oil piston rings, pistons and cylinder walls with light engine oil.

   IMPORTANT: Be sure to install pistons in same cylinders from which they were removed or to which they were fitted. Connecting rod and bearing caps are numbered from 1-to-4 in right bank and from 5-to-8 in left bank, beginning at front of engine. Numbers on connecting rod and bearing cap must be on same side when installed in cylinder bore. If a connecting rod is ever transposed from one block or cylinder to another, fit new bearings and number connecting rod to correspond with new cylinder number.

3. Make sure that ring gaps are properly spaced around circumference of piston. (Figure 8)
4. Install piston ring compressor on piston and push piston in with a hammer handle until piston is slightly below top of cylinder. (Figure 9) Be sure to guide connecting rods to avoid damaging crankshaft journals. Install piston with indentation notch in piston dome toward front of engine.
5. Check clearance of each bearing as outlined, preceding.
6. After bearings have been fitted, apply light coat of engine oil to journals and bearings.
7. Turn crankshaft throw to bottom of its stroke Push piston down until connecting rod bearing seats on crank shaft journal.
8. Install connecting rod cap. Torque nuts to specifications.

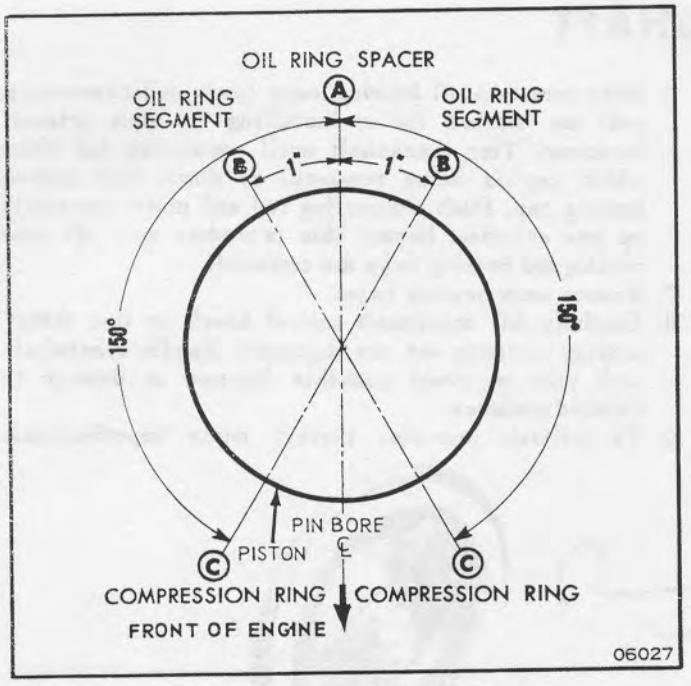

Figure 8. Piston Ring Spacing

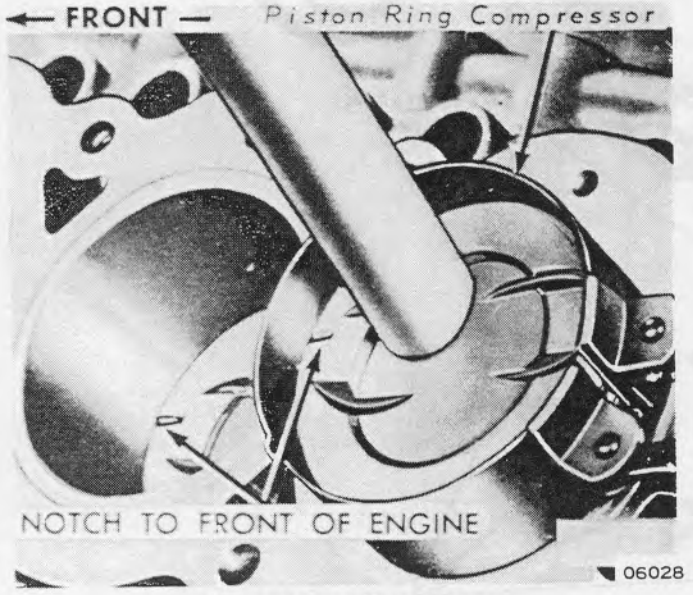

Figure 9. Installing Piston

9. After installing piston and connecting rod assemblies, check side clearance between connection rods on each crankshaft journal. (Figure 10)
10. Disassemble, clean and assemble oil pump. Clean all gasket surfaces.
11. Prime oil pump by filling either inlet port or outlet port with engine oil and rotating pump shaft to distribute oil within housing. Install oil pump and oil pan.
12. Install cylinder heads and intake manifold.
13. Fill crankcase with correct engine oil.
14. Operate engine at fast idle and check for oil and coolant leaks. When engine temperature has stabilized, adjust engine idle speed and idle fuel mixture.

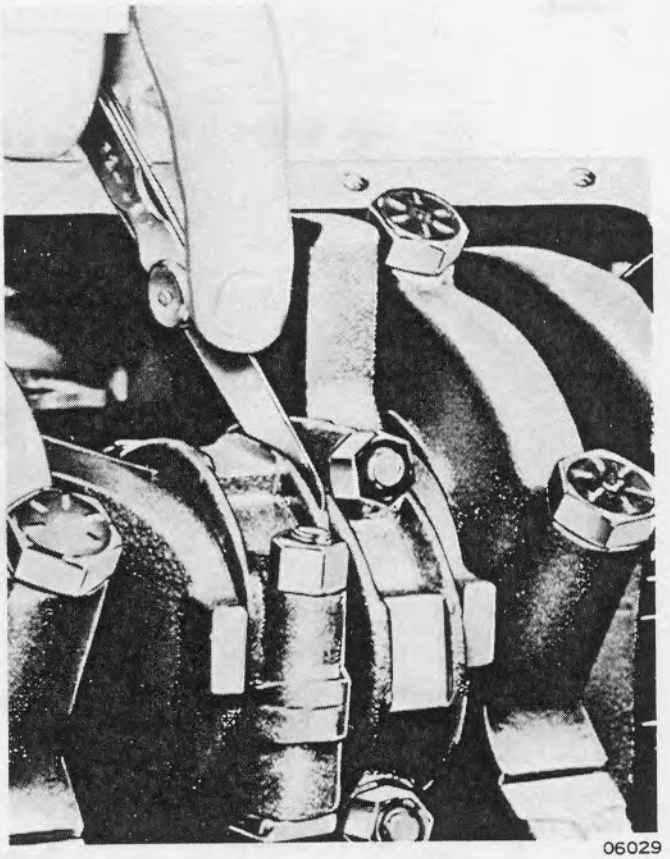

Figure 10. Checking Connecting Rod Side Clearance

CRANKSHAFT

Crankshaft and related parts are shown in Figure 1.

REMOVAL

1. Remove flywheel and mount engine inverted on an engine stand.
2. Remove oil pan and oil pump as outlined, preceding.
3. Remove cylinder block front cover as described previously.
4. Remove spark plugs to allow easy rotation of crankshaft.
5. Remove timing chain and sprockets as outlined, preceding.
6. Make sure that all bearing caps (main and connecting rod) are marked for re-installing in their original locations. Turn crankshaft until connecting rod (from which cap is being removed) is down, and remove bearing cap. Push connecting rod and piston assembly up into cylinder. Repeat this procedure until all connecting rod bearing caps are removed.
7. Remove main bearing caps.
8. Carefully lift crankshaft out of block so that thrust bearing surfaces are not damaged. Handle crankshaft with care to avoid possible fracture or damage to finished surfaces.
9. To refinish journals, correct minor imperfections.

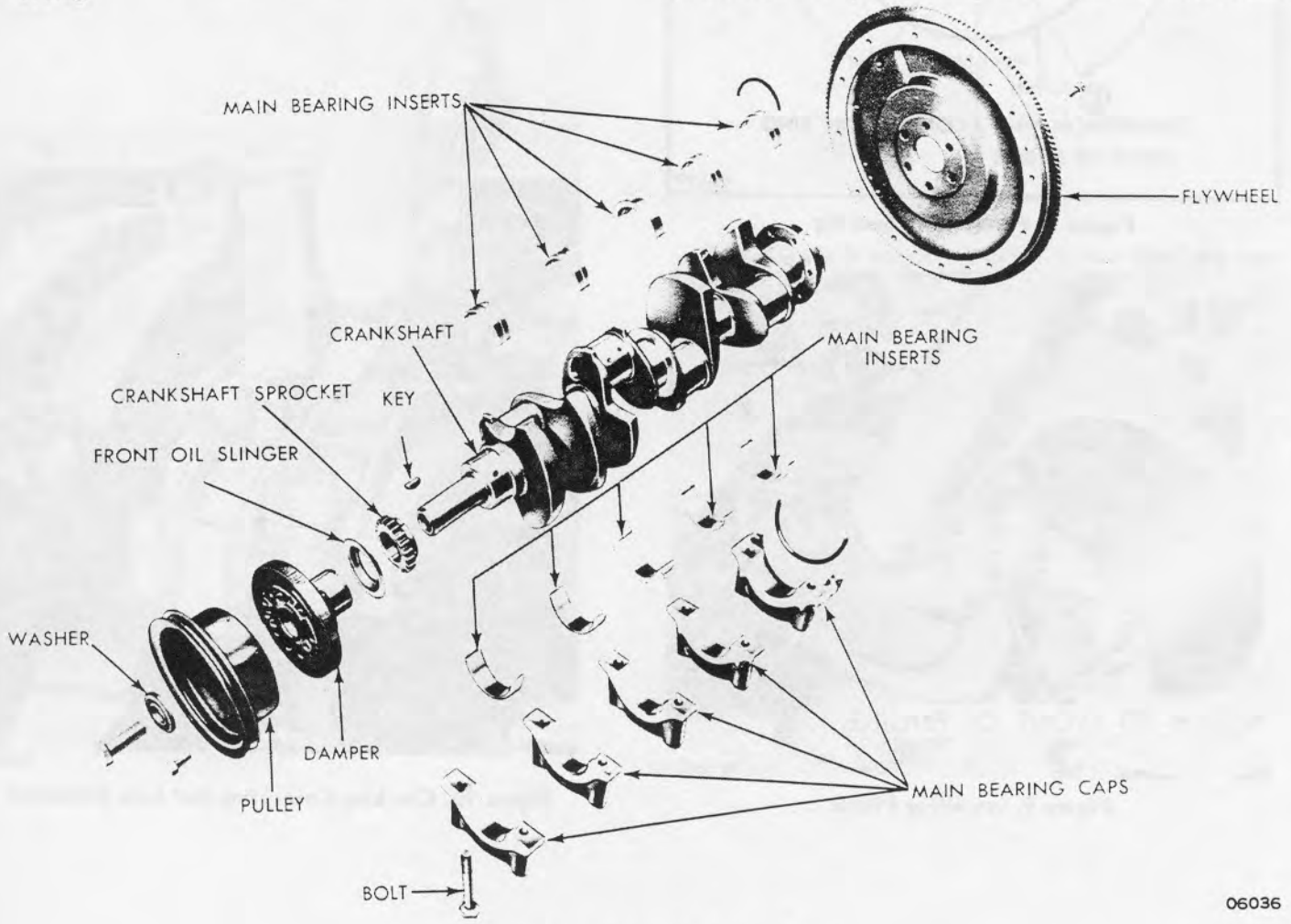

Figure 1. Crankshaft and Related Parts

CLEANING

1. Handle crankshaft with care to avoid possible fractures or damage to finished surfaces. Clean crankshaft with solvent, then blow out all oil passages with compressed air.
2. Use crocus cloth to remove sharp edges or burrs which might damage oil seal during installation or cause premature seal wear. DO NOT use crocus cloth to extent that seal surface becomes polished. A finely polished surface may produce poor sealing or cause premature seal wear.
3. Correct minor scores with an oil stone. If journals are severely marred or exceed wear limit, refinish to size for next undersize bearing.

REFINISHING JOURNALS

1. Refinish journals to give proper clearance with next undersize bearing. If journal will not clean up to maximum undersize bearing available, replace crankshaft.
2. Always reproduce same journal shoulder radius that existed originally. Too small a radius results in fatigue failure of crankshaft. Too large a radius results in bearing failure due to radius ride of bearing.

3. After refinishing journals, chamfer oil holes, then polish journal with No. 320 grit polishing cloth and engine oil. Crocus cloth also may be used as a polishing agent.

INSPECTION

1. Inspect main and connecting rod journals for cracks, scratches, grooves or scores. Inspect crankshaft oil seal surface for nicks, sharp edges or burrs which might damage oil seal during installation or cause premature seal wear.
2. Measure diameter of each journal in at least 4 places to determine out-of-round, taper or undersize condition. (Figure 2)

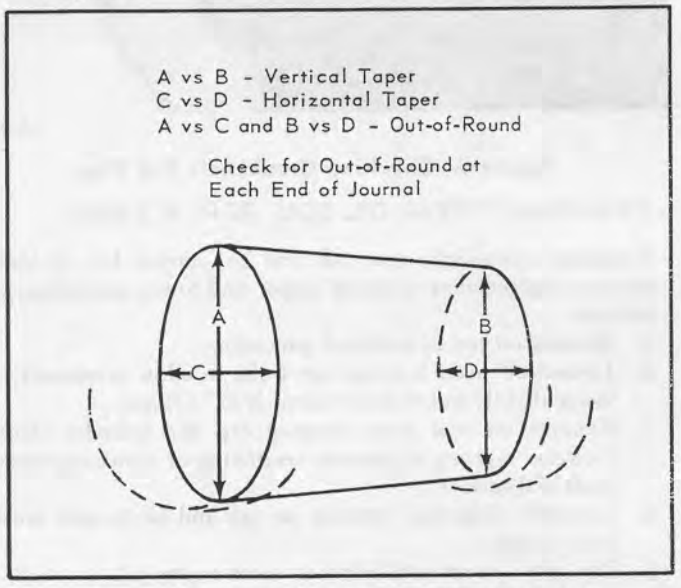

Figure 2. Crankshaft Journal Measurement

3. On engines with clutch and pressure plate, check fit of clutch pilot bushing in bore of crankshaft. Bushing is pressed into crankshaft and should not be loose. Inspect inner surface of bushing for wear or a bell-mouth condition. Check ID of bushing. (Figure 1) Replace worn or damaged bushing or if ID is not within specifications.

INSTALLATION

1. Remove rear journal oil seal from block and rear main bearing cap.
2. Remove main bearing inserts from block and bearing caps.
3. Remove connecting rod bearing inserts from connecting rods and caps.
4. If crankshaft main bearing journals are refinished to a definite undersize, install correct undersize bearings. Be sure that bearing inserts and bores are clean. Foreign material under inserts will distort bearing and cause a failure.
5. Place upper main bearing inserts in position in bores with tang fitting in slot provided.
6. Install lower main bearing inserts in bearing caps.
7. Install crankshaft rear oil seal as described previously.
8. Carefully lower crankshaft into place. Be careful not to damage bearing surfaces.
9. After bearings are fitted, apply a light coat of engine oil to journals and bearings. Install new seal in rear main bearing cap and install rear main bearing cap by following steps under "Main Bearing Replacement", preceding. Install all bearing caps, except thrust bearing cap (No. 3 bearing). Be sure that main bearing caps are installed in their original locations. Torque bearing cap bolts to specifications.
10. Install thrust bearing cap with bolts finger-tight.
11. Pry crankshaft forward against thrust surface of upper half of bearing. (Figure 3)
12. Hold crankshaft forward and pry thrust bearing cap to rear to align thrust surfaces of both halves of bearing.
13. Retain forward pressure on crankshaft. Tighten cap bolts to specifications.
14. Force crankshaft toward rear of engine.
15. Check crankshaft end play.
16. Install new bearing inserts in connecting rods and caps. Check clearance of each bearing following recommended procedure.
17. After fitting connecting rod bearings, apply a light coat of engine oil to journals and bearings.
18. Turn crankshaft throw to bottom of its stroke. Push piston all the way down until rod bearing seats on crankshaft journal.

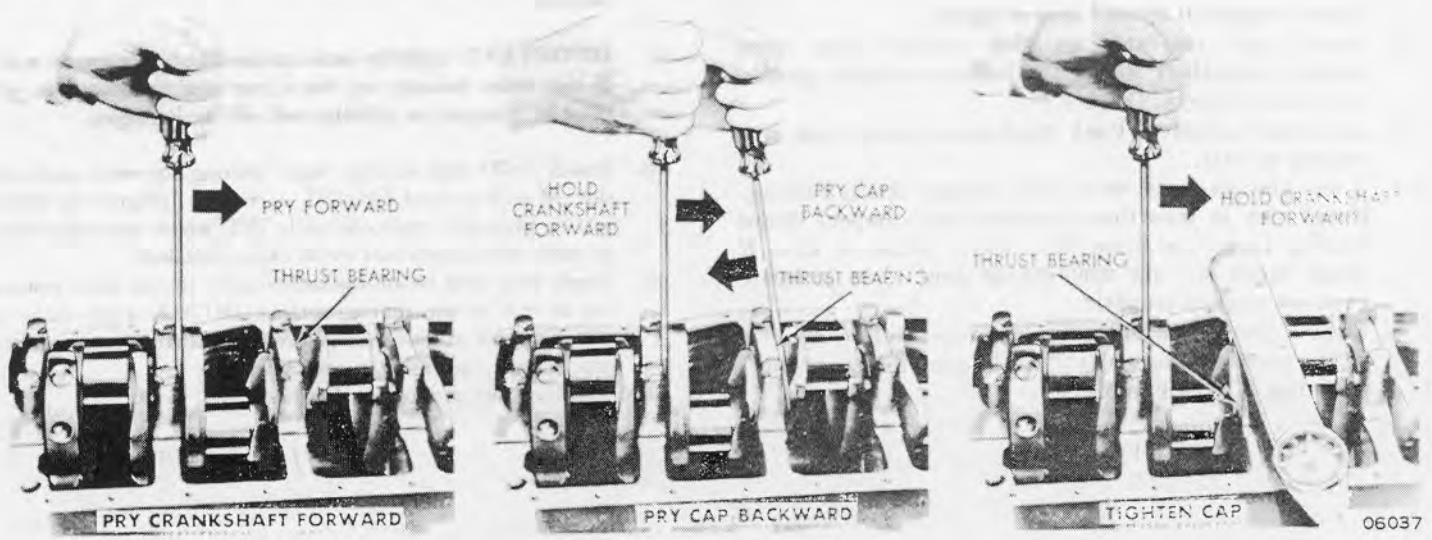

Figure 3. Aligning Thrust Bearing

19. Install connecting rod cap and torque nuts to specifications.
20. After installing piston and connecting rod assemblies, check side clearance between connecting rods on each connecting rod crankshaft journal. (Figure 4)
21. Install timing chain and sprockets.
22. Install cylinder block front cover.
23. Install oil pan and oil pump.
24. Remove engine from stand and install flywheel.
25. Install spark plugs.

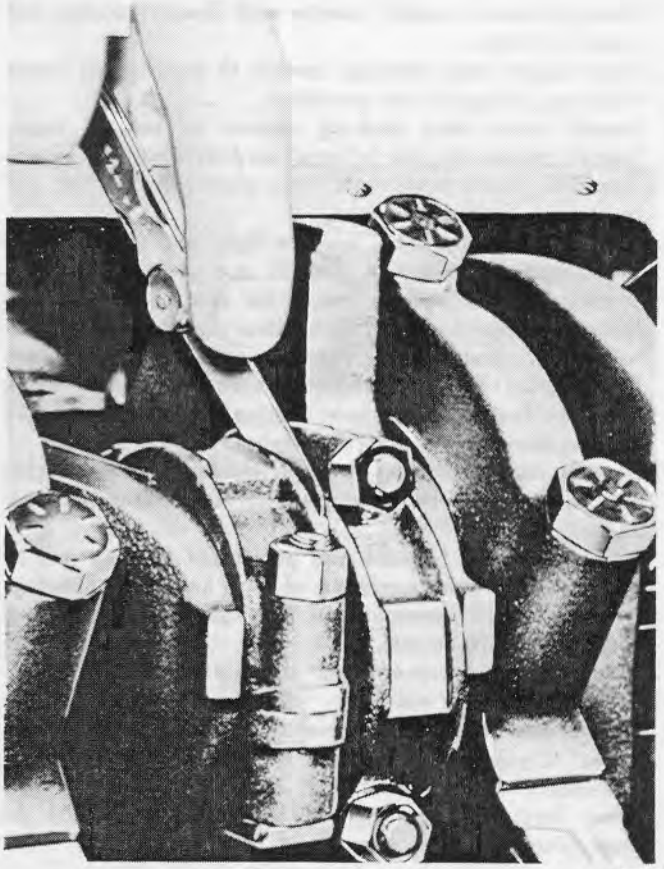

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Figure 4. Checking Connecting Rod Side Clearance

CRANKSHAFT END PLAY

1. Force crankshaft toward rear of engine.
2. Install dial indicator so that contact point rests against crankshaft flange and indicator axis is parallel to crankshaft axis. (Figure 5)
3. Zero dial indicator. Push crankshaft forward and note reading on dial.
4. If end play exceeds wear limit, replace thrust bearing. If end play is less than minimum limit, inspect thrust bearing faces for scratches, burrs, nicks or dirt. If thrust faces are not damaged or dirty, they probably were not aligned properly.
5. Install thrust bearing and align faces following procedure recommended under "Main Bearing Replacement", preceding. Check end play.

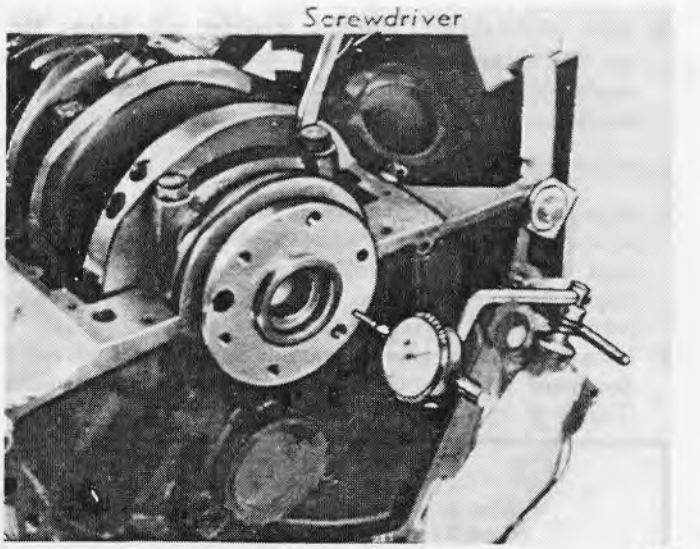

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Figure 5. Checking Crankshaft End Play

CRANKSHAFT REAR OIL SEAL REPLACEMENT

Replacing crankshaft rear oil seal to correct for oil leaks requires replacement of both upper and lower seal halves, as follows:

1. Remove oil pan as outlined, preceding.
2. Loosen all main bearing cap bolts to allow crankshaft to lower slightly but not to exceed 1/32" (.8mm).
3. Remove oil seal from bearing cap and cylinder block. Exercise caution to prevent scratching or damaging crankshaft seal surface.
4. Carefully clean seal grooves in cap and block with brush and solvent.
5. Dip split-lip type seal halves in clean engine oil.
6. Carefully install upper seal (cylinder block) into its groove with undercut side of seal toward FRONT of engine, (Figure 6) by rotating it on seal journal of crankshaft until approximately 3/8" (9.5mm) protrudes below parting surface.

   IMPORTANT: Be sure that no rubber has been shaved from outside diameter of seal by bottom edge of goove.

7. Tighten remaining bearing cap bolts and torque to specifications.

   IMPORTANT: Split-lip seals are used as replacement seals. If rear main bearing cap has a rear seal retaining pin, pin must be removed or split-lip seal will be damaged.

8. Install lower seal in rear main bearing cap with undercut side of seal toward FRONT of engine. (Figure 6) Allow seal to protrude approximately 3/8" above parting surface to mate with upper seal when cap is installed.
9. Apply thin coat of oil-resistant sealer to rear main bearing cap at rear of top mating surface. DO NOT apply sealer to area forward of side seal groove. Install rear main bearing cap. Torque cap bolts to specifications.
10. Install oil pan as described previously.

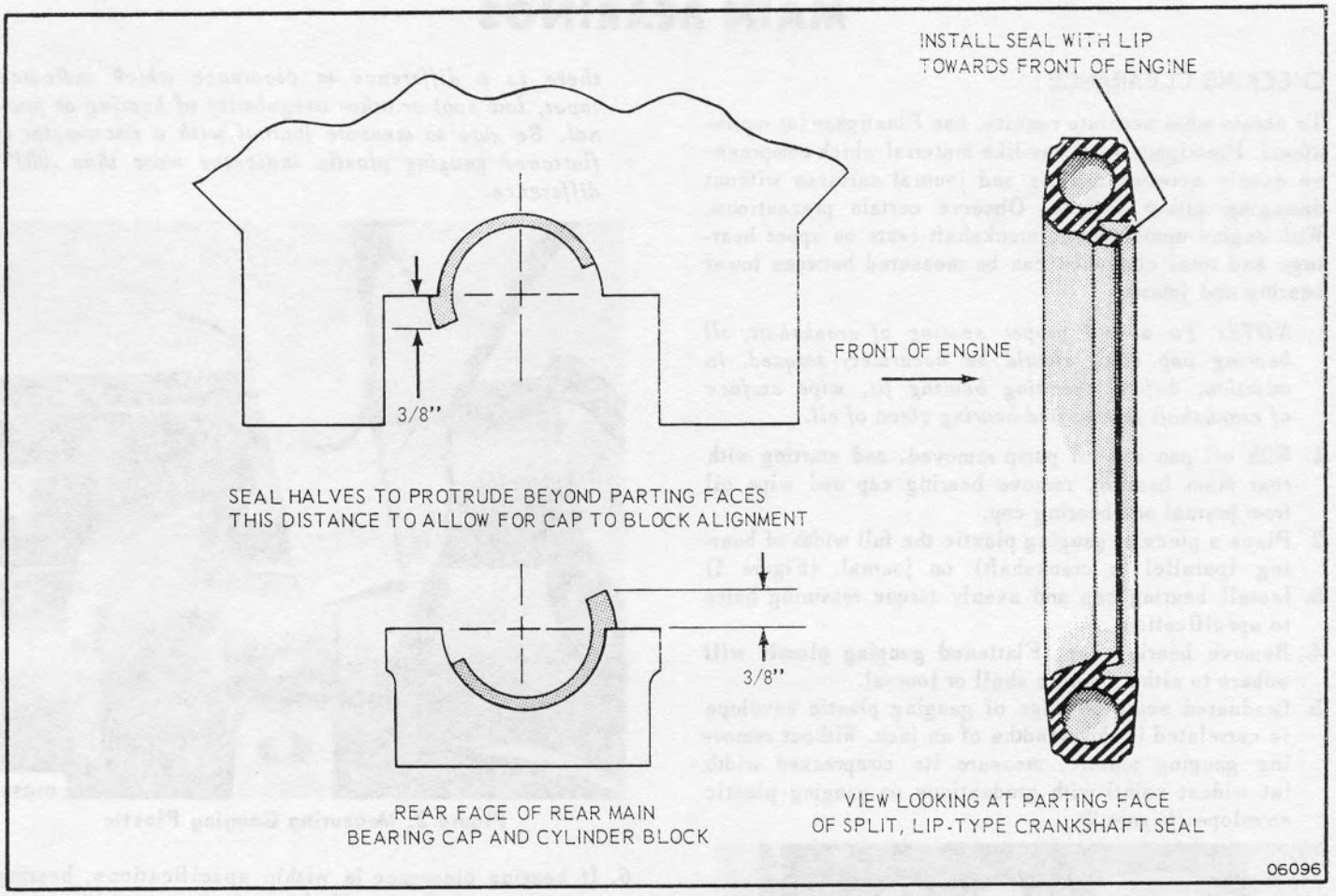


Figure 6. Installing Crankshaft Rear Seal

MAIN BEARINGS

CHECKING CLEARANCE

To obtain most accurate results, use Plastigage (or equivalent). Plastigage is a wax-like material which compresses evenly between bearing and journal surfaces without damaging either surface. Observe certain precautions. With engine upside-down, crankshaft rests on upper bearings and total clearance can be measured between lower bearing and journal.

NOTE: To assure proper seating of crankshaft, all bearing cap bolts should be accurately torqued. In addition, before checking bearing fit, wipe surface of crankshaft journal and bearing clean of oil.

1. With oil pan and oil pump removed, and starting with rear main bearing, remove bearing cap and wipe oil from journal and bearing cap.
2. Place a piece of gauging plastic the full width of bearing (parallel to crankshaft) on journal. (Figure 1)
3. Install bearing cap and evenly torque retaining bolts to specifications.
4. Remove bearing cap. Flattened gauging plastic will adhere to either bearing shell or journal.
5. Graduated scale on edge of gauging plastic envelope is correlated in thousandths of an inch. Without removing gauging plastic, measure its compressed width (at widest point) with graduations on gauging plastic envelope. (Figure 2)

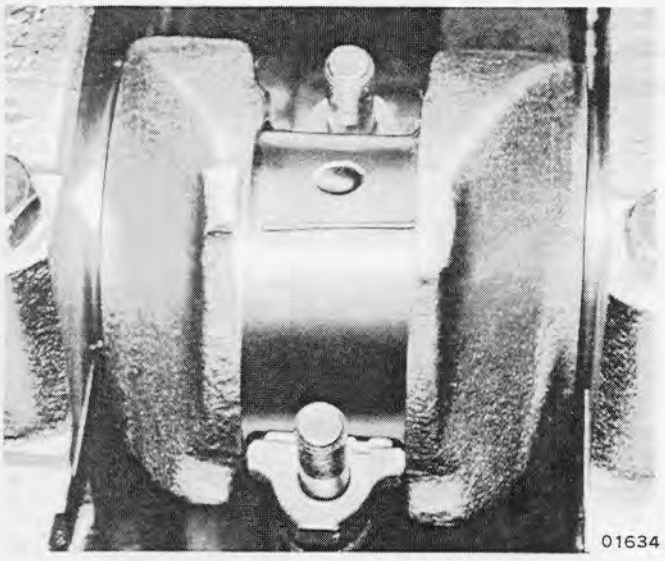


Figure 1. Gauging Plastic on Journal

NOTE: Normally, main bearing journals wear evenly and are not out-of-round. However, if a bearing is being fitted to an out-of-round journal (.001" [.025mm] max.), be sure to fit to maximum diameter of journal. If bearing is fitted to minimum diameter and journal is out-of-round .001", interference between bearing and journal will result in rapid bearing failure. If flattened gauging plastic tapers toward middle or ends, there is a difference in clearance which indicates taper, low spot or other irregularity of bearing or journal. Be sure to measure journal with a micrometer if flattened gauging plastic indicates more than .001" difference.

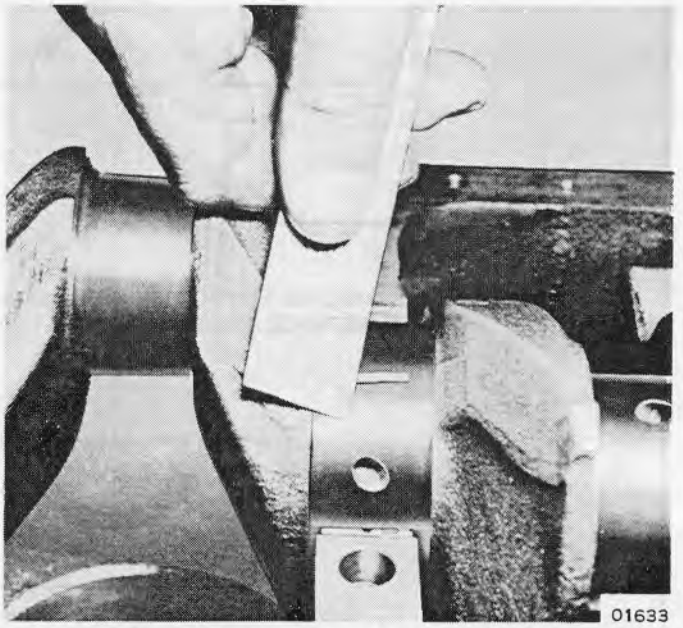


Figure 2. Measuring Gauging Plastic

6. If bearing clearance is within specifications, bearing insert is satisfactory. If clearance is not within specifications, replace insert. Always replace both upper and lower insert as a unit.

   NOTE: If a new bearing cap is being installed and clearance is less than .001", inspect for burrs or nicks. If none is found, then install shims as required.

7. A standard .001" or .002" [.025 or .05mm] undersize bearing may produce proper clearance. If not, regrind crankshaft journal for use with next undersize bearing.
8. Proceed to next bearing. After all bearings have been checked, rotate crankshaft to see that there is no excessive drag.
9. Measure crankshaft end play (see specifications in Section 8). Measure crankshaft end play with a dial indicator as outlined in crankshaft section.
10. Install new rear main bearing oil seal in cylinder block and main bearing cap.

REPLACEMENT

1. Remove and inspect crankshaft.
2. Remove main bearings from cylinder block and main bearing caps.
3. Coat bearing surfaces of new, correct size, main bearings with oil and install in cylinder block and main bearing caps.
4. Install crankshaft.

CONNECTING ROD BEARINGS

Connecting rod bearings are precision insert type and do not utilize shims for adjustment. DO NOT FILE RODS OR ROD CAPS. If clearances are found to be excessive, a new bearing will be required. Bearings are available in standard size and .001" and .002" (.025 and .05mm) undersize for new and used standard size crankshafts, and in .010" and .020" (.254 and .51mm) undersize for reconditioned crankshafts.

CHECKING CLEARANCE and REPLACEMENT

1. With oil pan and oil pump off, remove connecting rod cap and bearing.
2. Inspect bearing for evidence of wear or damage. Do not reinstall defective bearings.
3. Wipe bearings and crankpin clean of oil.
4. Measure crankpin for out-of-round or taper with a micrometer. If not within specifications, replace or recondition crankshaft. If within specifications and a new bearing is to be installed, measure maximum diameter of crankpin to determine new bearing size required.
5. If within specifications, measure new or used bearing clearances with Plastigage or equivalent.

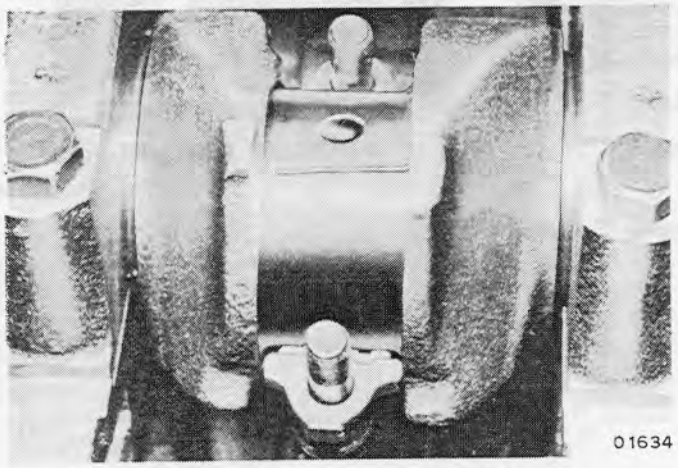


Figure 3. Plastigage on Crankpin

NOTE: If a bearing is being fitted to an out-of-round crankpin, be sure to fit to maximum diameter of crankpin. If bearing is fitted to minimum diameter, and crankpin is out-of-round .001" (.025mm), interference between bearing and crankpin will result in rapid bearing failure.

a. Place a piece of gauging plastic the full width of crankpin (parallel to crankshaft). (Figure 3)
b. Install bearing in connecting rod and cap.
c. Install bearing cap and torque nuts evenly to specifications.

> CAUTION: Do not turn crankshaft with gauging plastic installed.

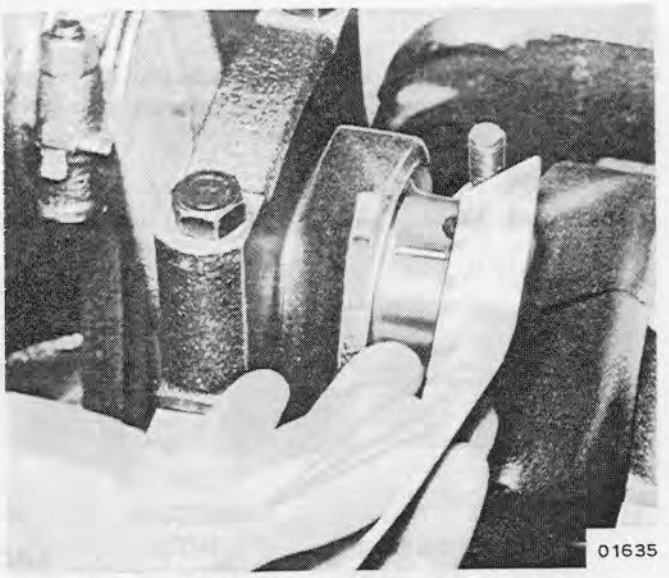


Figure 4. Measuring Plastigage on Crankpin

d. Remove bearing cap and, using scale on gauging plastic envelope, measure gauging plastic width at widest point. (Figure 4)

6. If clearance exceeds specifications, select a new, correct size bearing and remeasure clearance.
7. Coat bearing surface with oil, install rod cap and torque nuts to specifications.
8. When all connecting rod bearings have been installed, tap each rod lightly (parallel to crankpin) to assure clearance.
9. Measure all connecting rod side clearances (see specifications in Section 8) between connecting rod cap(s). (Figure 5)

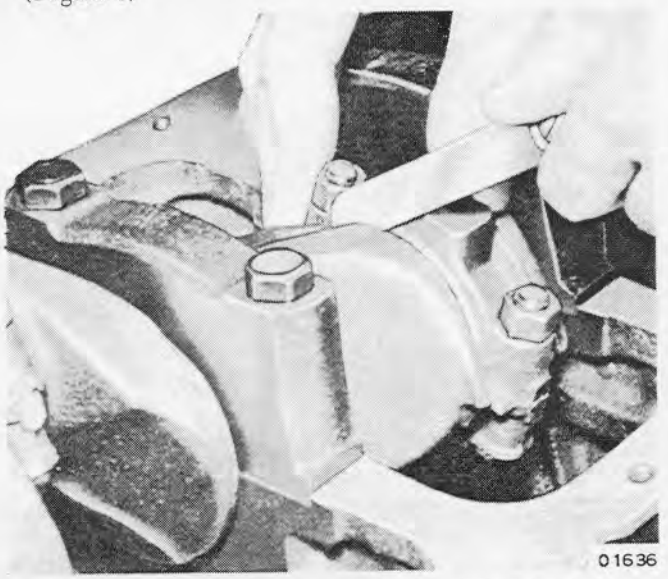


Figure 5. Checking Connecting Rod Side Clearance

MAIN and CONNECTING ROD BEARING INSERTS

CLEANING

Clean bearing inserts and caps thoroughly in solvent and dry with compressed air. **DO NOT scrape gum or varnish deposits from bearing shells.**

INSPECTION

Inspect each bearing carefully. Replace bearings with scored, chipped or worn surface. Typical examples of unsatisfactory bearings and causes are shown in Figure 6. Copper lead bearing base may be visible thru bearing overlay. This does not mean that bearing is worn. It is not necessary to replace bearing if bearing clearance is within recommended limits. Check clearance of apparent satisfactory bearings with Plastigage. Fit new bearings.

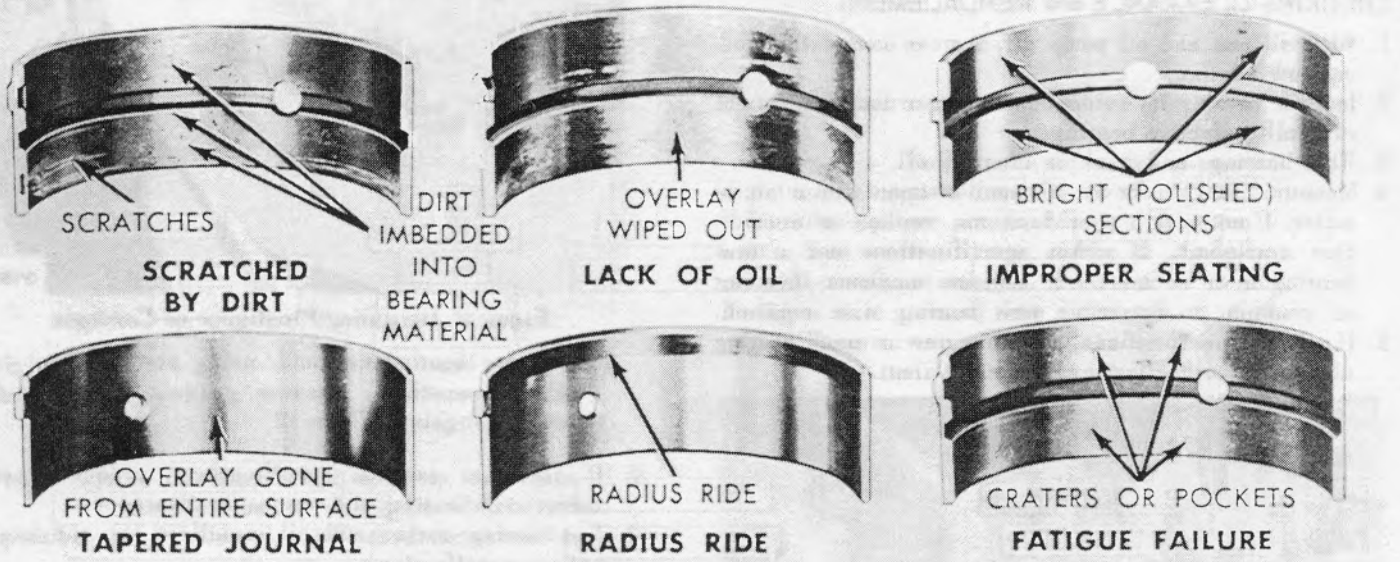


Figure 6. Typical Bearing Failures

TORSIONAL DAMPER

REMOVAL

1. Remove alternator belt.
2. Remove pulley by removing 3 attaching bolts.
3. Remove torsional damper retaining bolt.
4. Install Tool T58P-6316A and T62F-6316B and pull off torsional damper. (Figure 1)

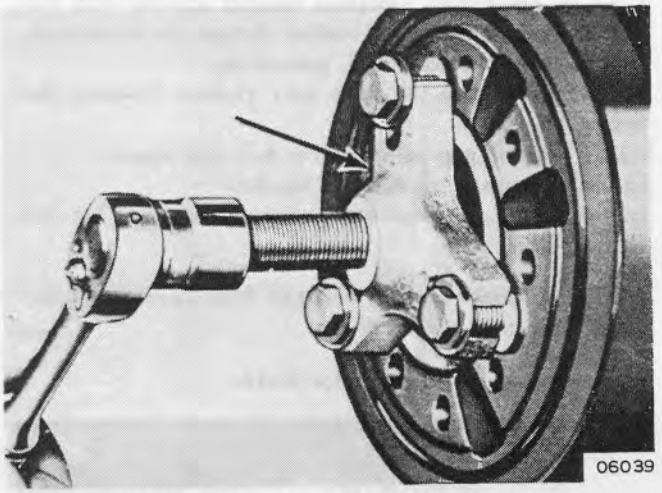


Figure 1. Removing Crankshaft Vibration Damper

CLEANING

1. Clean oil seal contact surface on crankshaft damper or sleeve with solvent to remove any corrosion, sludge or varnish deposits. Excess deposits, that are not readily removed with solvent, may be removed with crocus cloth.
2. Use crocus cloth to remove any sharp edges or burrs which might damage the oil seal during installation or cause premature seal wear. **DO NOT use crocus cloth to polish seal surface. A finely polished surface may produce poor sealing or cause premature seal wear.**

INSPECTION

Inspect crankshaft damper or sleeve oil seal surface for nicks, sharp edges or burrs that might damage oil seal during installation or cause premature seal wear.

INSTALLATION

CAUTION: Inertia weight section of torsional damper is assembled to hub with a rubber type material. Installation procedures (with proper tool) must be followed, or movement of inertia weight section on hub will destroy tuning of torsional damper.

1. Pull torsional damper onto crankshaft with tool T52L-6306-AEE. (Figure 2)
2. Install retaining bolt and washer.
3. Install pulley and alternator belt.

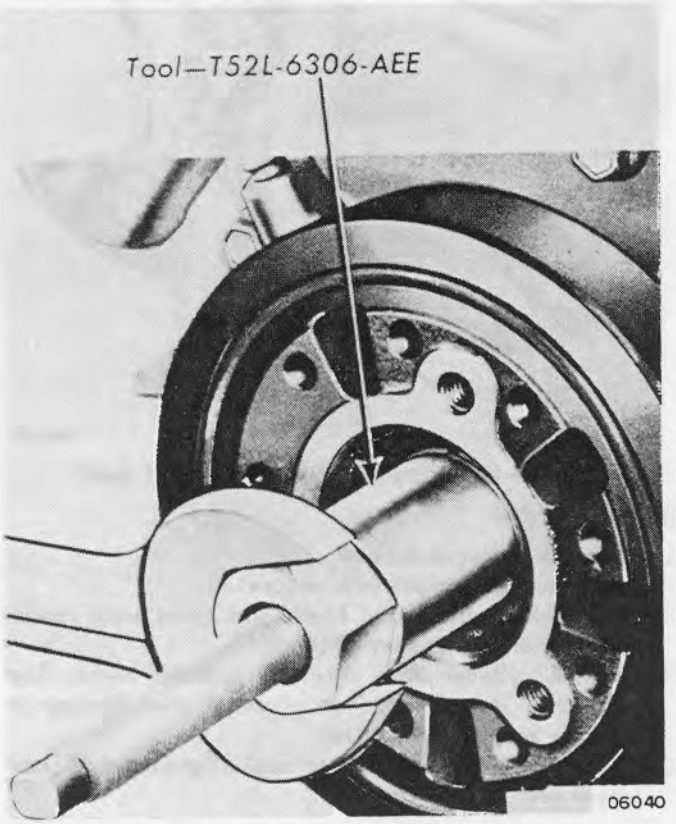


Figure 2. Installing Crankshaft Vibration Damper

CYLINDER BLOCK FRONT COVER and FRONT SEAL

REMOVAL

1. Drain water and oil from engine.
2. Remove oil pan as outlined.
3. Remove alternator adjustment bracket.
4. Remove alternator and seawater pump as an assembly by removing mounting bracket from cylinder block front cover.
5. Remove circulating water pump pulley and drive belt.
6. Remove torsional damper as outlined.
7. Remove fuel filter and fuel pump.
8. Remove cylinder block front cover and water pump as an assembly. Transfer water pump to new cylinder block front cover, if cover is being replaced.
9. Discard cylinder block front cover gasket.

FRONT OIL SEAL REPLACEMENT

1. Drive out old seal with a pin-punch. Clean out recess in cover.
2. Coat new seal with grease, then install seal in cover. Drive seal in until fully seated in recess. (Figure 3) Check seal after installation to be sure that spring is properly positioned in seal.

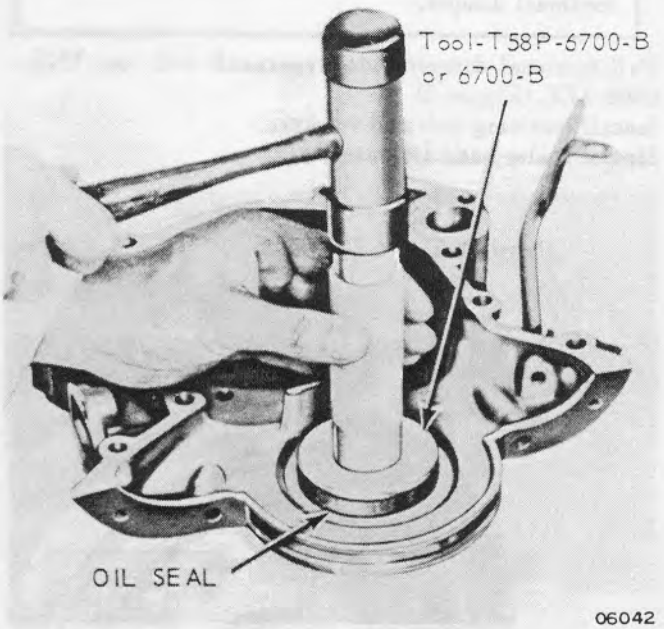


Figure 3. Installing Crankshaft Front Oil Seal

INSTALLATION

1. Clean all gasket surfaces.
2. Lubricate timing chain with engine oil.
3. Coat gasket surfaces of block and cover with sealer and position new gasket on block.
4. Position cylinder front cover on cylinder block. Use care when installing cover to avoid seal damage or possible gasket mislocation.
5. Install cylinder front cover to seal alignment tool into proper position. (Figure 4)
6. Coat threads of attaching screws with oil resistant sealer and install screws. Torque cover-to-block attaching screws to specifications. Remove pilot.
7. Apply Lubriplate to oil seal rubbing surface of vibration damper inner hub to prevent damage to the seal. Apply white lead and oil mixture to front of crankshaft for damper installation.
8. Line up crankshaft vibration damper keyway with key on crankshaft. Install vibration damper on crankshaft.
9. Install oil pan as outlined, preceding.
10. Install fuel pump, using a new gasket. Connect fuel pump outlet line.
11. Install water pump pulley, drive belt and spacer.
12. Install alternator adjustment bracket.
13. Install alternator, seawater pump and mounting bracket. Install drive belts.

    NOTE: A spacer is used between front cover and alternator/seawater pump bracket.

14. Operate engine and check for leaks.

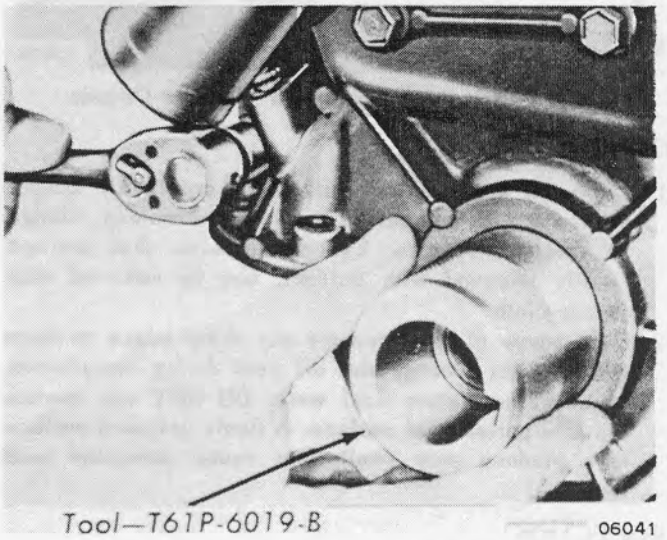


Figure 4. Front Cover Installation

TIMING CHAIN, SPROCKETS and FUEL PUMP ECCENTRIC

REMOVAL

1. Remove cylinder block front cover.
2. Slide off crankshaft front oil slinger.
3. Check timing chain deflection.
4. Crank engine until timing marks on sprockets are positioned as shown in Figure 7.
5. Remove crankshaft sprocket cap screw, washers and fuel pump eccentric. Slide both sprockets and timing chain forward and remove as an assembly.

TIMING CHAIN and SPROCKETS

CLEANING

1. Clean all parts in solvent and dry with compressed air.
2. Lubricate timing chain with engine oil before installing on engine.

INSPECTION

1. Inspect chain for broken links.
2. Inspect sprockets for cracks and worn or damaged teeth.
3. Replace all components of timing chain and sprocket assembly if any one item needs replacement.

TIMING GEARS

CLEANING

Clean gears in solvent, and dry with compressed air.

INSPECTION

Inspect gear teeth for scores, nicks, etc. Note condition of teeth contact pattern. If teeth are scored, replace gears.

FUEL PUMP ECCENTRIC

CLEANING

Clean fuel pump eccentric in solvent and dry with compressed air.

INSPECTION

Inspect fuel pump drive eccentric for scores, nicks and excessive wear. Replace eccentric if scored.

TIMING CHAIN DEFLECTION

1. Rotate crankshaft in clockwise direction (as viewed from front) to take up slack on left side of chain.
2. Establish a reference point on cylinder block and measure from this point to chain (Figure 5)
3. Rotate crankshaft in opposite direction to take up slack on right of chain. Force left side of chain out with fingers and measure distance between reference point and chain. The deflection is difference between the 2 measurements.

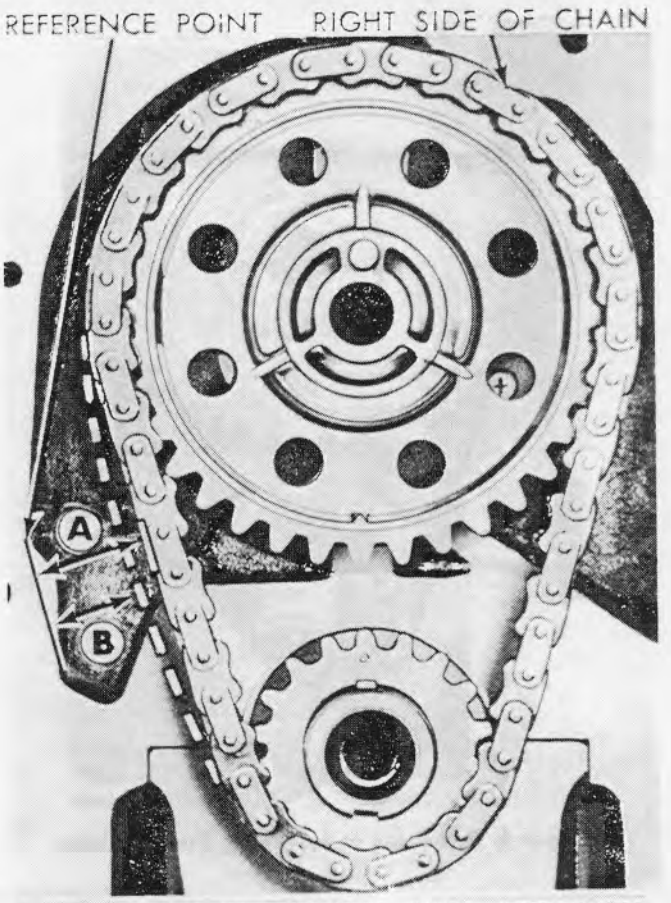


Figure 5. Checking Timing Chain Deflection

If deflection exceeds specifications, replace timing chain and sprockets.

INSTALLATION

1. Position sprockets and timing chain on cam shaft. (Figure 6) Be sure that timing marks on sprockets are positioned as shown in Figure 7.
2. Install fuel pump eccentric, washers and camshaft sprocket cap screw. Torque cap screw to specifications and install crankshaft oil slinger. (Figure 8)

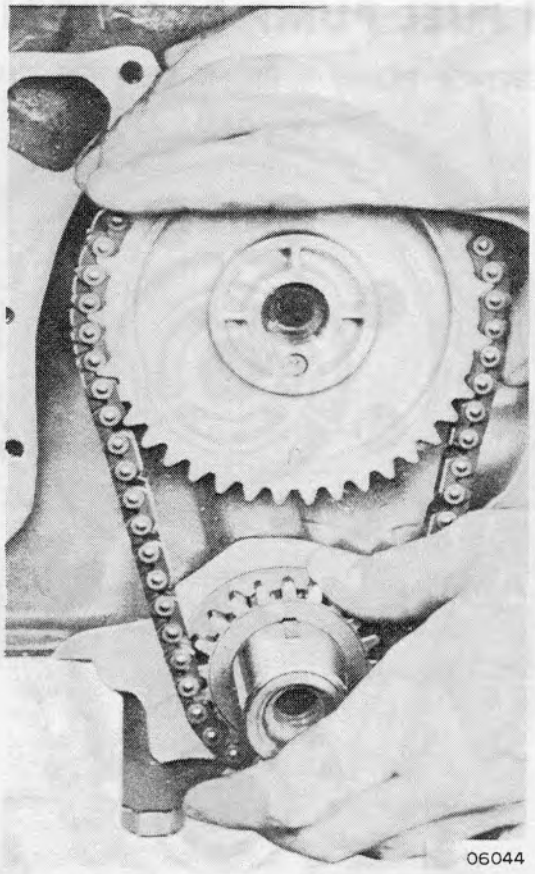


Figure 6. Removing or Installing Timing Chain

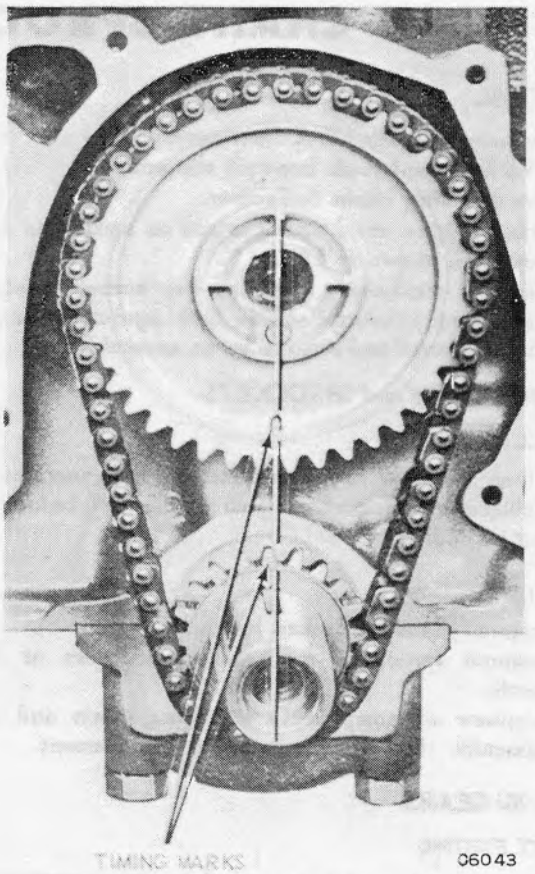


Figure 7. Aligning Timing Marks

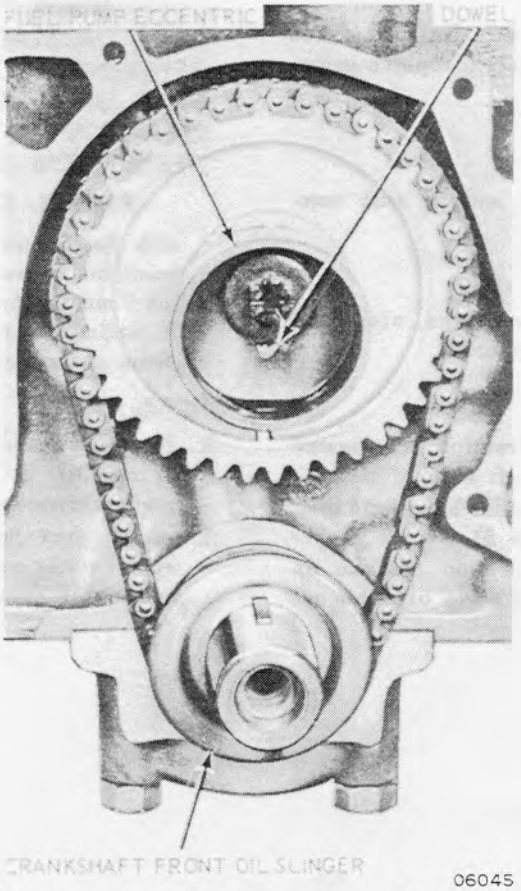


Figure 8. Fuel Pump Eccentric and Front Oil Slinger Installed

CAMSHAFT

Camshaft and related parts are shown in Figure 1.

REMOVAL

1. Remove cylinder front cover and timing chain, following procedure under "Cylinder Front Cover and Timing Chain Removal", preceding.
2. Disconnect coil high tension lead from coil. Remove distributor cap and spark plug wire assembly.
3. Disconnect ignition coil wires from coil.
4. Remove distributor hold-down bolt and clamp and remove distributor.
5. Remove rocker arm covers as outlined, preceding.
6. Remove intake manifold as described previously.
7. Remove valve mechanism as outlined, preceding.
8. Remove camshaft thrust plate. Carefully remove camshaft by pulling toward front of engine. Use caution to avoid damaging camshaft bearings.

CLEANING AND INSPECTION

1. Clean camshaft in solvent and wipe dry.
2. Inspect camshaft lobes for scoring and signs of abnormal wear. Lobe wear characteristics may result in pitting in general area of lobe toe. This pitting is not detrimental to operation of camshaft, therefore, do not replace camshaft until lobe lift loss has exceeded .005" (.13mm).
3. Check lift of camshaft lobes with camshaft installed in engine or on "V" blocks. Refer to "Camshaft Lobe Lift", preceding.
4. Check distributor drive gear for broken or chipped teeth.
5. Remove light scuffs, scores or nicks from camshaft machined surfaces with a smooth oil stone.

INSTALLATION

1. Oil camshaft journals and apply Lubriplate to lobes. Carefully slide camshaft thru bearings. Install camshaft thrust plate with groove toward cylinder block. Check camshaft end play.
2. Install valve mechanism as outlined.
3. Install intake manifold and related parts as outlined previously.
4. Connect water temperature sending unit.

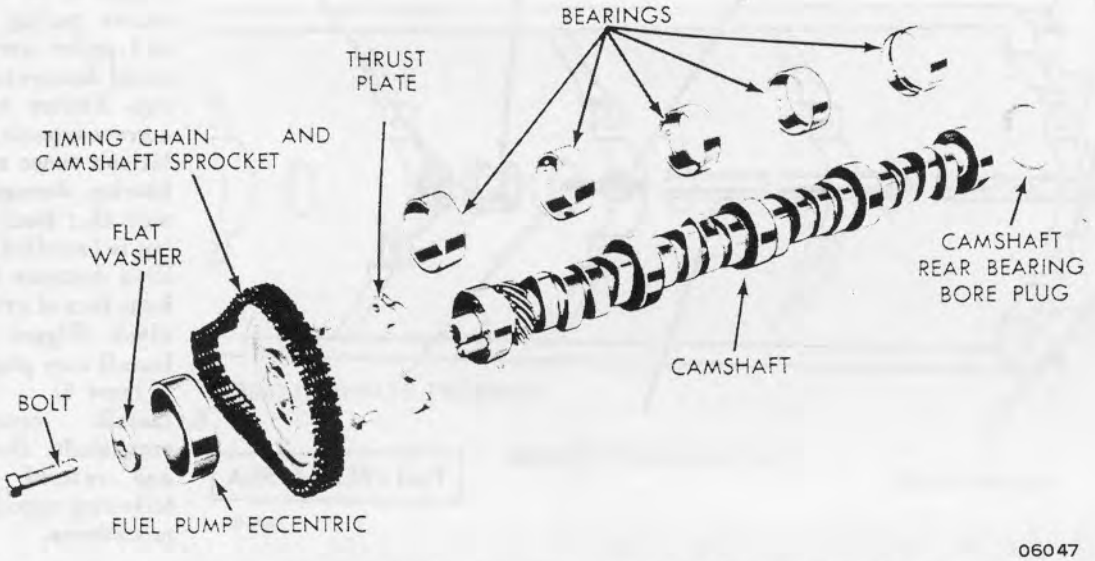


Figure 1. Camshaft and Related Parts

5. Connect throttle cable.
6. Replace crankshaft front oil seal. Install timing chain, cylinder front cover and related parts.
7. With No. 1 piston on TDC at end of compression stroke, position distributor in block with rotor at No. 1 firing position and points open. Install hold-down clamp.
8. Check valve clearance as outlined, preceding.
9. Install rocker arm covers as described previously.
10. Clean and install crankcase ventilation system.
11. Connect ignition coil wires.
12. Install distributor cap and plug wires. Connect high tension lead at coil.
13. Fill crankcase with proper engine oil.
14. Start engine and check and adjust ignition timing.
15. Operate engine at fast idle and check all hose connections and gaskets for leaks. When engine temperature has stabilized, adjust engine idle speed and idle fuel mixture.

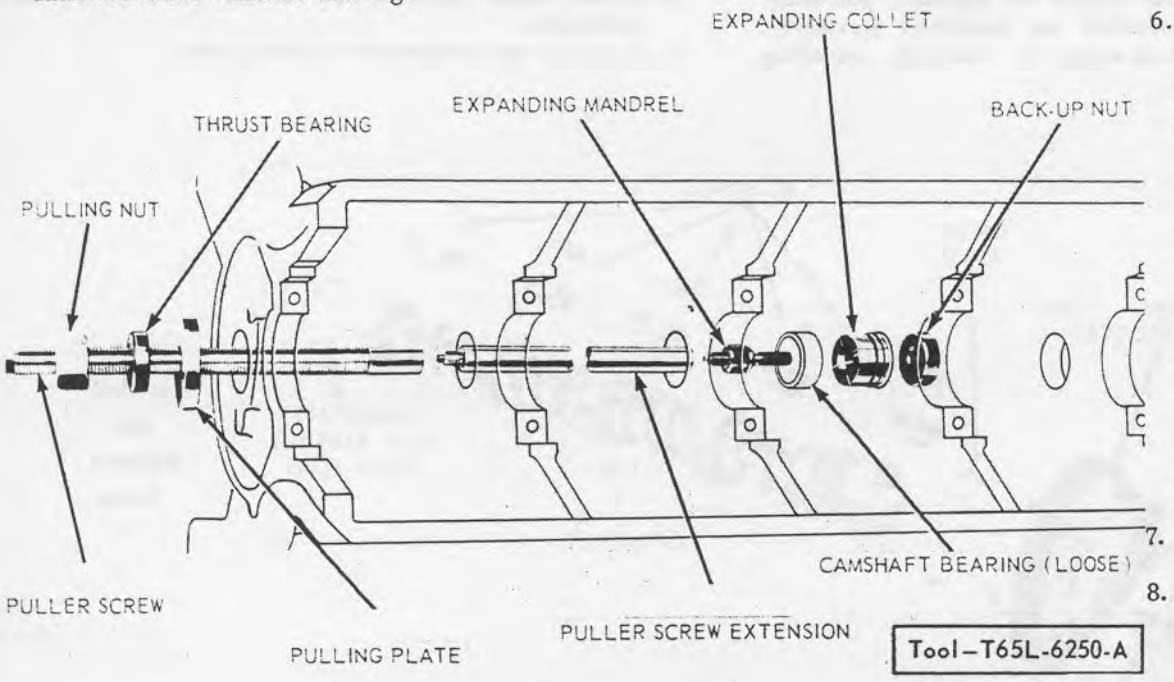
CAMSHAFT BEARING REPLACEMENT

Camshaft bearings are available pre-finished to size for standard journal diameters. Bearings are not interchangeable from one bore to another.

1. Remove camshaft, flywheel and crankshaft, following appropriate procedures. Push pistons to top of cylinders.
2. Remove camshaft rear bearing bore plug. Remove camshaft bearings with Tool T65L-6250-A. (Figure 2)
3. Select proper size expanding collet and back-up nut and assemble on expanding mandrel. With expanding collet collapsed, install collet assembly in camshaft bearing and tighten back-up nut on expanding mandrel until collet fits camshaft bearing.

NOTE: Camshaft bearing diameters vary. Replacement bearings are numbered according to location in cylinder block. No. 1 bearing is at front of block.

4. Assemble puller screw and extension (if necessary) as shown and install on expanding mandrel. Wrap a cloth around threads of puller screw to protect front bearing or journal. Tighten pulling nut against thrust bearing and pulling plate to remove camshaft bearing. Be sure to hold a wrench on end of puller screw to prevent screw from turning.
5. Repeat procedure for each bearing. To remove front bearing, install puller screw from rear of cylinder block.



6. Position new bearings at bearing bores with oil holes aligned and press in place with tool shown in Figure 2. Be sure to center pulling plate and puller screw to avoid damage to bearing. Failure to use correct expanding collet can cause severe bearing damage. Be sure that front bearing is installed specified distance below front face of cylinder block. (Figure 3)
7. Install core plug. (Figure 4)
8. Install camshaft, crankshaft, flywheel and related parts, following appropriate procedures.

Figure 2. Camshaft Bearing Replacement

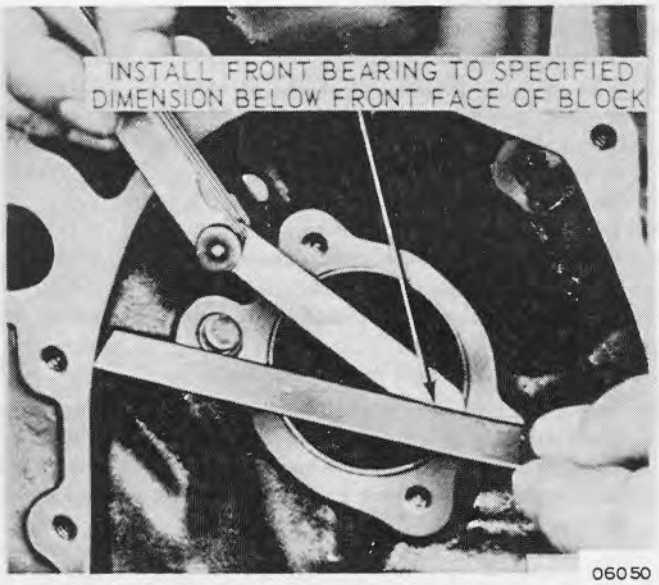


Figure 3. Camshaft Front Bearing Measurement

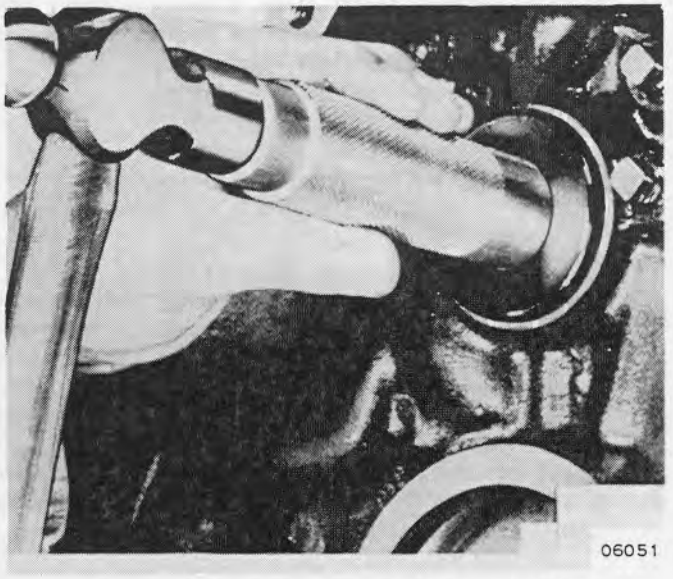


Figure 4. Installing Camshaft Bearing Plug

CAMSHAFT LOBE LIFT

Check lift of each lobe in consecutive order and make a note of readings.

1. Remove valve rocker arm cover(s).
2. Remove rocker arm stud nut, ball unit and rocker arm. Use adaptor for ball-end push rods.
3. Be sure that push rod is in valve lifter socket. Install dial indicator so that ball socket adaptor of indicator is on end of push rod and in same plane as push rod movement. (Figure 5)
4. Disconnect ignition coil.
5. Turn crankshaft over until tappet or lifter is on base circle of camshaft lobe. At this point, push rod will be in its lowest position.
6. Zero the dial indicator. Continue to rotate crankshaft slowly until push rod is in fully-raised position (highest indicator reading).
7. Compare total lift (recorded on indicator) with specifications.
8. To check accuracy of original indicator reading, continue to rotate crankshaft until indicator reads zero. If lift on any lobe is below specified wear limits, replace camshaft and valve lifters operating on worn lobe(s).

IMPORTANT: Do not rotate crankshaft until hydraulic valve lifters have had sufficient time to bleed down. Manually bleeding down will reduce time requirement. To do otherwise may cause serious valve damage.

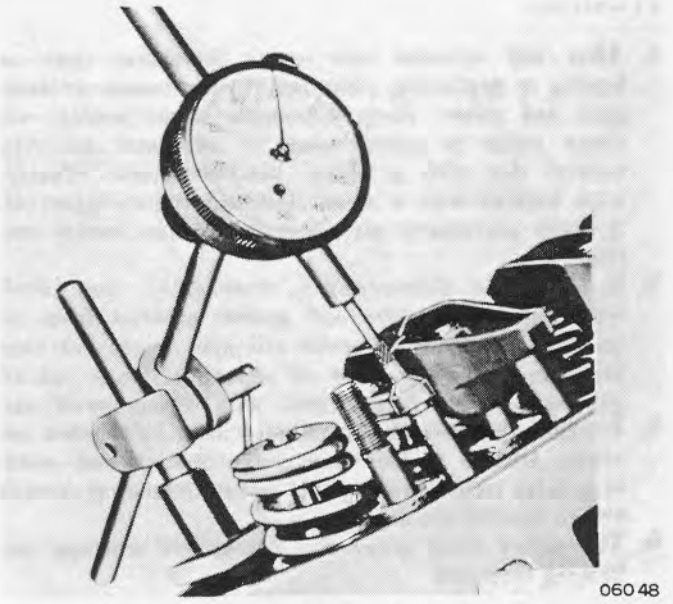


Figure 5. Testing Camshaft Lobe Lift - Stud Mounted Rock Arms

9. Remove dial indicator and auxiliary starter switch.
10. Lubricate rocker arm and ball unit with molycote and secure them in position with stud nut.
11. Install valve rocker arm cover(s).

CAMSHAFT END PLAY

1. Sprocket can break or become damaged by prying against aluminum-nylon camshaft sprocket with valve train load on camshaft. Rocker arm adjusting nuts, therefore, must be backed off sufficiently to free camshaft. After checking camshaft end play, adjust valve clearance.
2. Push camshaft toward rear of engine. Install dial indicator so that indicator point is on camshaft sprocket attaching screw (Figure 6) or gear hub. Zero dial indicator. Position a large screwdriver between camshaft sprocket or gear and block. Pull camshaft forward and release it.
3. Compare dial indicator reading with specifications. If end play is excessive, replace thrust plate. If a spacer is used, check spacer for correct installation before it is removed. If spacer is correctly installed, replace thrust plate.
4. Remove dial indicator.

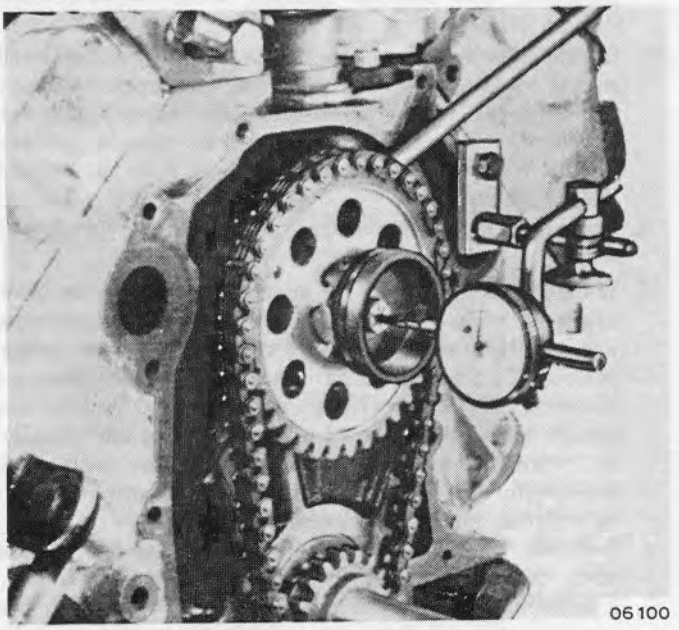


Figure 6. Checking Camshaft End Play - V-8 Engine

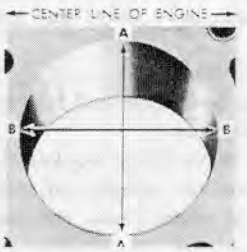
CYLINDER BLOCK

CLEANING

1. After any cylinder bore repair operation, such as honing or deglazing, clean bore(s) with soap or detergent and water. Then, thoroughly rinse bore(s) with clean water to remove soap or detergent and wipe bore(s) dry with a clean, lint-free cloth. Finally, wipe bore(s) with a clean cloth dipped in engine oil. If these procedures are ignored, cylinder bore(s) may rust.
2. If engine is disassembled, thoroughly clean block with solvent. Remove old gasket material from all machined surfaces. Remove all pipe plugs that seal oil passages, then clean all passages. Blow out all passages, bolt holes, etc, with compressed air.
3. Be sure that threads in cylinder head bolt holes are clean. Dirt in threads may cause binding and result in a false torque reading. Use a tap to true-up threads and to remove any deposits.
4. Thoroughly clean grooves in crankshaft bearings and bearing retainers.

INSPECTION

1. After thoroughly cleaning block, check for cracks. Minute cracks (not visible to naked eye) may be detected by coating suspected area with mixture of 25% kerosene and 75% light engine oil. Wipe part dry and immediately apply coating of zinc oxide dissolved in wood alcohol. If cracks are present, coating will become discolored at defective area. Replace block, if it is cracked.
2. Check all machined gasket surfaces for burrs, nicks, scratches and scores. Remove minor imperfections with an oil stone.
3. Check cylinder block for flatness of cylinder head gasket surface following procedure and specifications recommended for cylinder head. Cylinder block can be machined to bring cylinder head gasket surface within flatness specifications, but not to exceed .010" (.254mm).
4. Replace all expansion-type plugs with evidence of leakage.
5. Inspect cylinder walls for scoring, roughness or other signs of wear. Check cylinder bore for out-of-round and taper. Measure bore with an accurate bore gauge, following instructions of the manufacturer. Measure diameter of each cylinder bore at top, middle and bottom with gauge placed at right angles and parallel to centerline of engine. (Figure 7) Use only measurements obtained at 90° to engine centerline when calculating piston to cylinder bore clearance.
6. Refinish cylinders which are deeply scored and/or when out-of-round and/or taper exceeds wear limits.
7. If cylinder walls have minor surface imperfections, but out-of-round and taper are within limits, it may be possible to remove imperfections by honing cylinder walls and installing new service piston rings, if piston clearance is within specified limits.



"A" = At right angle to centerline of engine
"B" = Parallel to centerline of engine
"Out-of-round" = Difference between "A" and "B"
"Taper" = Difference between measurement at top of cylinder bore and "A" measurement at bottom of cylinder bore.

Figure 7. Cylinder Bore Out-of-Round and Taper

REFINISHING CYLINDER WALLS

1. Honing is recommended for refinishing cylinder walls only when walls have minor scuffs or scratches, or for fitting pistons to specified clearance. The grade of hone is determined by amount of metal to be removed. Follow instructions of hone manufacturer. If coarse stones are used to start honing operation, leave enough material so that all hone marks can be removed with finishing hone which is used to obtain proper piston clearance.
2. Refinish cylinder walls that are severely marred and/or worn beyond specified limits. Before any cylinder is refinished, all main bearing caps must be in place and tightened to proper torque so that crankshaft bearing bores will not become distorted from refinishing operation.
3. Refinish only damaged cylinder or cylinders. All pistons are same weight, both standard and oversize, therefore, various piston sizes can be used without upsetting engine balance.
4. To determine maximum oversize, refinish cylinder with most wear first. If cylinder will not clean up when refinished for maximum oversize piston, replace block.
5. Refinish cylinder to within approximately .0015" (.038mm) of required oversized diameter. This will allow enough stock for final step of honing so that correct surface finish and pattern are obtained.
6. For proper use of refinishing equipment, follow instructions of manufacturer. Only experienced personnel should perform this work.
7. Use a motor-driven, spring-pressure-type hone at a speed of 300-500 RPM. Hones of grit sizes 180-220 will normally provide desired bore surface finish of 15/32 RMS. When honing cylinder bores, use a lubricant mixture of equal parts of kerosene and SAE No. 20 motor oil. Operate hone to produce a cross-hatch finish on cylinder bore. Cross-hatch pattern should be at an angle of approximately 30° to cylinder bore.
8. After final operation in either of 2 refinishing methods described, and prior to checking piston fit, thoroughly clean and oil cylinder walls.
9. Check piston fit following procedure in this section. Mark pistons to correspond to cylinders for reinstallation. When cylinder refinishing has been completed

and all pistons are fitted, thoroughly clean entire block and oil cylinder walls following procedure under "Cylinder Block Cleaning", preceding.

FITTING PISTONS

1. Pistons are available for service in standard sizes .003" and .020" (.076 and .508mm) oversizes.
2. Measure piston OD and cylinder bore. Dimensions should be within specifications, and piston to bore clearance (bore ID minus piston OD) must be within specified limits.
3. If clearance is greater than maximum limit, recheck calculations to be sure that proper-size piston has been selected or check for a damaged piston, then try a new piston.
4. If clearance is less than minimum limit, recheck calculations before trying another piston. If none can be fitted, refinish cylinder to provide correct piston clearance.

   NOTE: When a piston has been fitted, mark it for assembly in cylinder to which it was fitted.
5. If taper, out-of-round and piston-to-cylinder-bore clearance conditions of cylinder bore are within specified limits, new piston rings will give satisfactory service.
6. If installing new rings in a used cylinder, that has not been refinished, remove cylinder wall glaze (refer to "Cylinder Block, Refinishing Cylinder Walls", preceding). Be sure to clean cylinder bore thoroughly.

TO FIT A PISTON . . . .

1. Calculate size piston required by taking a cylinder bore check.
2. Select proper size piston to provide desired clearance (refer to specifications). Measure piston diameter in line with centerline of piston pin and at 90° to piston pin axis.
3. Make sure that piston and cylinder block are at room temperature (70°F). After any refinishing operation, allow cylinder bore to cool and make sure that piston and bore are clean and dry before piston fit is checked.

REPAIRING ENGINE CASTING

1. Porosity or sand hole(s), which cause oil seepage or leakage, can occur with modern casting processes. Make complete inspection of engine and transmission. If leak is attributed to porous condition of cylinder block or sand hole(s), make repairs with metallic plastic. DO NOT repair cracks with this material. Confine repairs to those cast iron engine component surfaces (Figure 8) where inner wall surface is not exposed to engine coolant pressure or oil pressure, for example:
   a. Cylinder block surfaces extending along length of block, upward from oil pan rail to cylinder water jacket but not including machined areas.
   b. Lower rear face of cylinder block.
   c. Intake manifold casting. Repairs are not recommended to intake manifold exhaust crossover section, since temperatures can exceed recommended temperature limit of 500° F.
   d. Cylinder front cover on engines using cast iron material.
   e. Cylinder head, along rocker arm cover gasket surface.
2. Use following procedure to repair porous areas or sand holes in cast iron.
   a. Clean surface to be repaired by grinding or rotary filing to a clean bright metal surface. Chamfer or undercut hole or porosity to a greater depth than rest of cleaned surface. Solid metal must surround hole. Openings larger than ¼" (6.35mm) should not be repaired with metallic plastic. Openings in excess of ¼" can be drilled, tapped and plugged with common tools. Clean repair area thoroughly. Metallic plastic will not stick to a dirty or oil surface.
   b. Mix metallic plastic base and hardener as directed on container. Stir thoroughly until uniform.

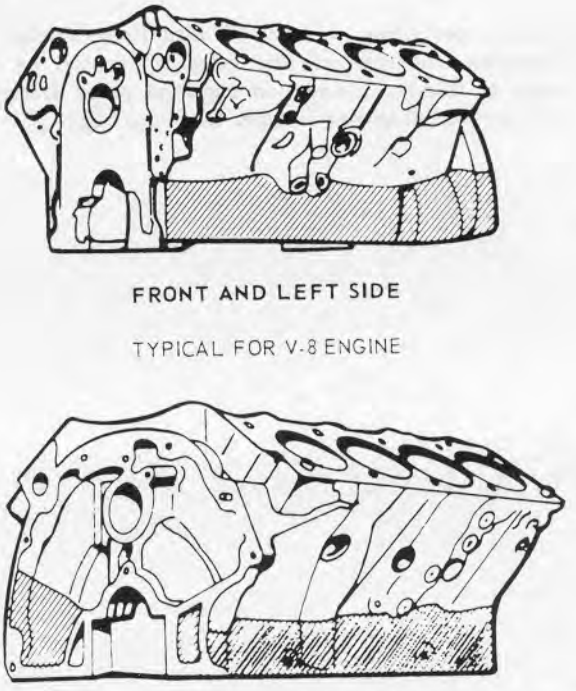


Figure 8. Typical Cast Iron Cylinder Block Areas Repairable with Metallic Plastic

   c. Apply repair mixture with a suitable clean tool (putty knife, wood spoon, etc), forcing epoxy into hole or porosity.
   d. Allow repair mixture to harden by one of 2 methods: Heat cure with a 250° watt lamp placed 10" (25.4cm) from the repaired surface, or air dry for 10-12 hours at temperatures above 50° F.
   e. Sand or grind repaired area to blend with general contour of surrounding surface.
   f. Paint surface to match rest of block.

CORE PLUG REPLACEMENT

REMOVAL

1. To remove a large core plug, drill a ½" (12.7mm) hole in center of plug and pry it out with a large, drift punch.
2. On a small core plug, drill a ¼" (6.35mm) hole in center of plug and pry it out with a small pin punch. Clean and inspect plug bore.
3. Prior to installing a core plug, inspect plug bore for any damage that would interfere with proper sealing of plug. If bore is damaged, it is necessary to true surface by boring for next specified oversize plug.
4. Oversize (OS) plugs are identified by OS stamped in flat located on cup side of plug.
5. Coat plug and/or bore lightly with an oil-resistant (oil galley) or water-resistant (cooling jacket) sealer and install it via procedure for cup-type or expansion-type, below.

INSTALLATION

1. Install core plugs (Figure 9) with flanged edge out. Maximum diameter of this plug is located at outer edge of flange. Flange on cup-type plugs flares out with largest diameter at outer (sealing) edge.

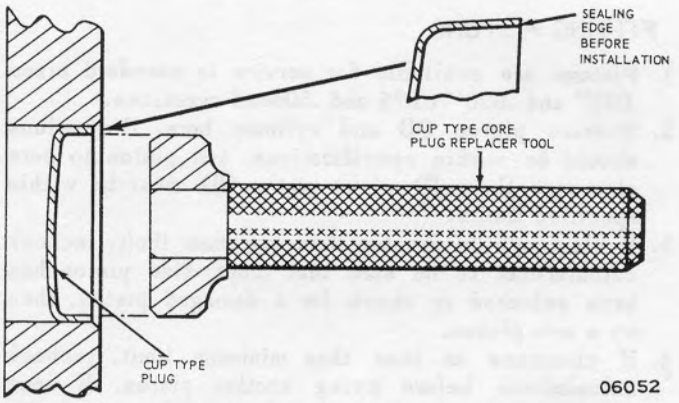
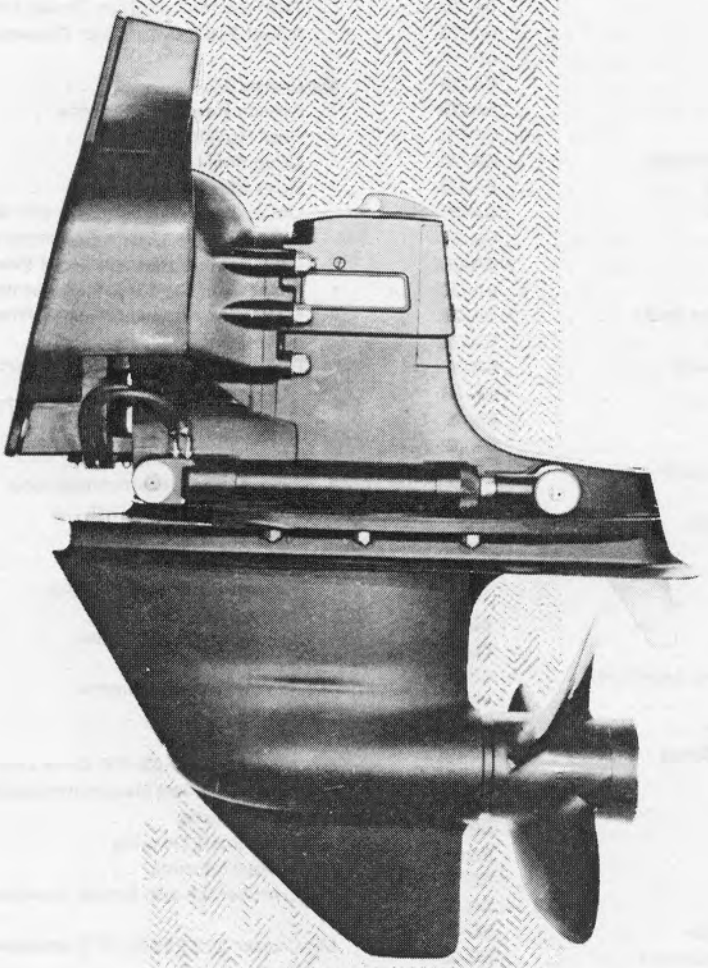


Figure 9. Core/Plug Replacement

IMPORTANT: Pull plug into machined bore only with a properly designed tool. Under no circumstances is plug to be driven into bore with a tool that contacts flange. This method will damage sealing edge and result in leakage and/or plug blow-out.

2. Flanged (trailing) edge must be below chamfered edge of bore to effectively seal the plugged bore. If core plug replacing tool has a depth seating surface, DO NOT seat the tool against a non-machined (casting) surface.

MERCRUISER
SECTION 6



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SECTION 6 - DRIVE SYSTEMS

MERCRUISER

PART A - MERCRUISER 60-thru-165 and 888

MERCURY MARINE

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MERCRUISER 60 - thru - 888 DRIVE UNITS

SERVICE RECOMMENDATIONS

This section includes all of the important detailed information that pertains to servicing MerCruiser Stern Drive Units. Instructions are printed in the sequence which will be followed to assure best results when removing or replacing components. In order to assure correct and durable operation after assembly, it is important that all adjustments and torque value specifications, stated herein, be maintained to the highest degree of accuracy. Repair procedures for the different model units are noted.

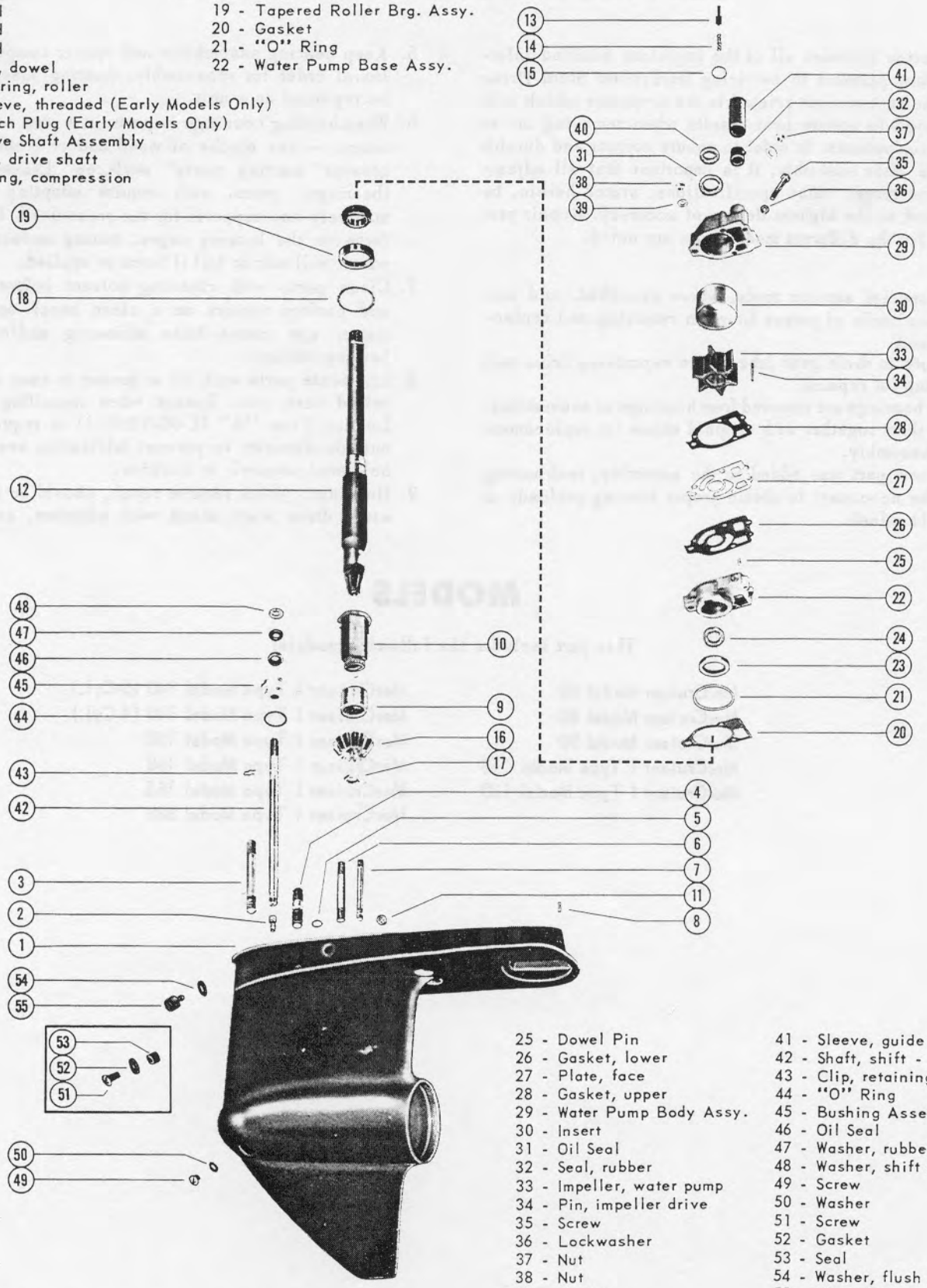
1. Use special service tools, where specified, and use common tools of proper fit when removing and replacing parts.
2. Be sure to drain gear lube before separating drive unit housing for repairs.
3. When bearings are removed from housings or assemblies, keep them together with original shims for replacement in reassembly.
4. If a new part was added to the assembly, reshimming will be necessary to obtain proper bearing preloads or gear backlash.
5. Keep bearing assemblies and spacer components in removal order for reassembly. Bearing assemblies must be replaced as a unit.
6. When holding housings or parts in a vise -- or by other means -- use blocks of wood and/or brass shields to prevent marring parts' surfaces. Pressed-on parts (bearings, gears, etc) require adapting appropriate mandrels and supports for the press used. Do not apply force on the bearing cages, mating surfaces or edges which will mar or fail if force is applied.
7. Clean parts with cleaning solvent before inspection and perform repairs on a clean bench area. Foreign matter can cause false shimming and/or premature bearing failure.
8. Lubricate parts with oil or grease to ease installation, retard rust, etc. Except when installing oil seals, Loctite Type "A" (C-92-32609-1) is required on seal outside diameter to prevent lubrication seepage and to hold seal securely in position.
9. Housings, which require repair, should be installed on stern drive work stand with adaptors, as specified.

MODELS

This part includes the following models:

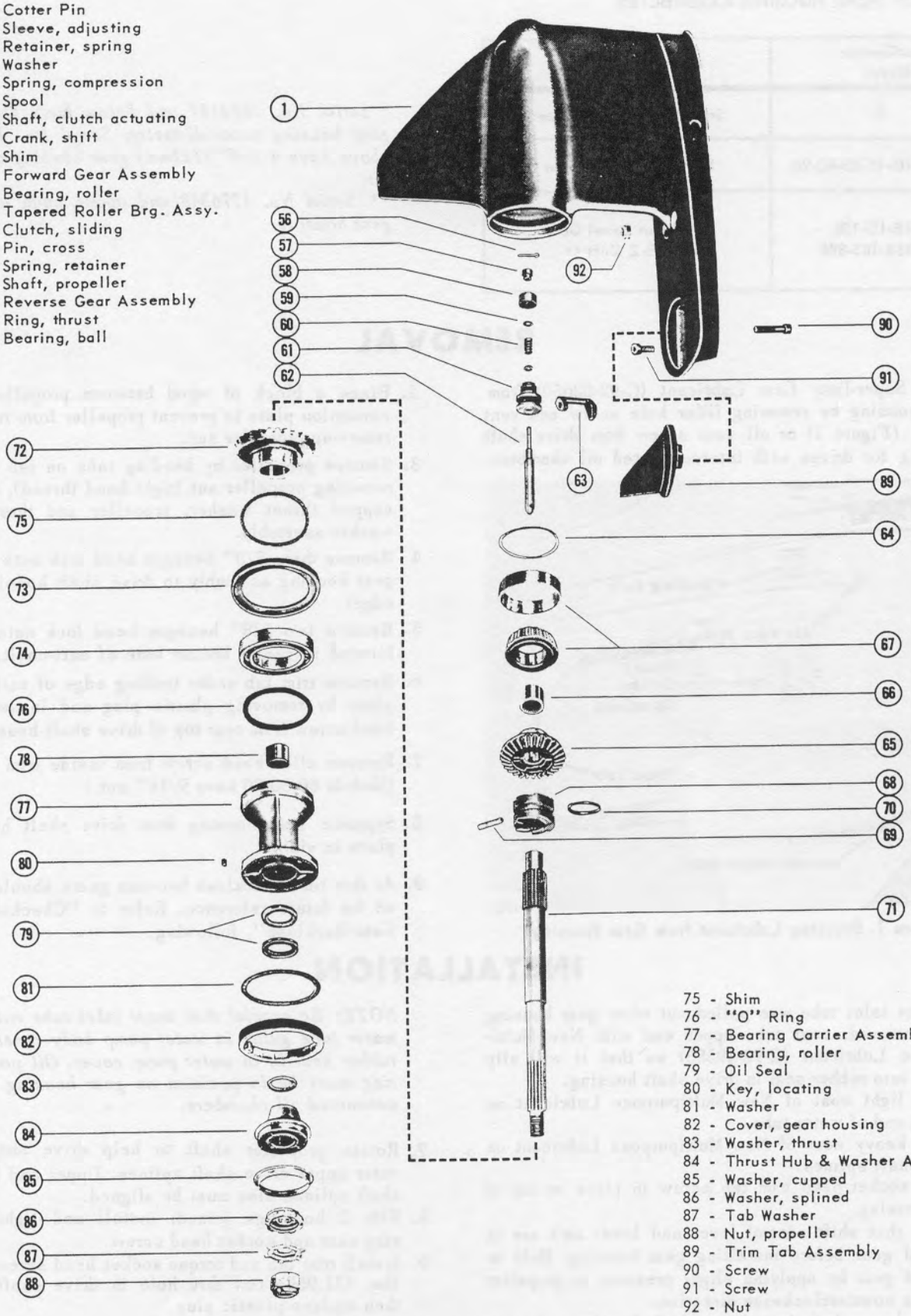
MerCruiser Model 60
MerCruiser Model 80
MerCruiser Model 90
MerCruiser I Type Model 110
MerCruiser I Type Model 120
MerCruiser I Type Model 140 (6-Cyl.)
MerCruiser I Type Model 140 (4-Cyl.)
MerCruiser I Type Model 150
MerCruiser I Type Model 160
MerCruiser I Type Model 165
MerCruiser I Type Model 888

1 - Gear Housing Assembly
2 - Pin, shift crank
3 - Stud
4 - Stud
5 - Seal
6 - Stud
7 - Stud
8 - Pin, dowel
9 - Bearing, roller
10 - Sleeve, threaded (Early Models Only)
11 - Welch Plug (Early Models Only)
12 - Drive Shaft Assembly
13 - Pin, drive shaft
14 - Spring, compression
15 - "O" Ring, upper
16 - Gear, pinion
17 - Nut
18 - Shim
19 - Tapered Roller Brg. Assy.
20 - Gasket
21 - "O" Ring
22 - Water Pump Base Assy.
23 - Oil Seal
24 - Oil Seal



25 - Dowel Pin
26 - Gasket, lower
27 - Plate, face
28 - Gasket, upper
29 - Water Pump Body Assy.
30 - Insert
31 - Oil Seal
32 - Seal, rubber
33 - Impeller, water pump
34 - Pin, impeller drive
35 - Screw
36 - Lockwasher
37 - Nut
38 - Nut
39 - Washer
40 - Ring, rubber
41 - Sleeve, guide
42 - Shaft, shift - lower
43 - Clip, retaining
44 - "O" Ring
45 - Bushing Assembly
46 - Oil Seal
47 - Washer, rubber
48 - Washer, shift shaft
49 - Screw
50 - Washer
51 - Screw
52 - Gasket
53 - Seal
54 - Washer, flush plug
55 - Plug, flush

Figure 1. Gear Housing Assembly Complete



(Continued) **Figure 1. Gear Housing Assembly Complete**

GEAR HOUSING

TYPES OF GEAR HOUSING ASSEMBLIES

MerCruiser Model	Gear Housing Type
1*	Straight Cut Bevel Gear
1*-1A-1B-1C-60-80-90	Spiral Cut Bevel Gear
1A-1B-1C-120-140-160-165-888	Spiral Cut Bevel Gear with E-Z Shift **

** Serial No. 1684187 and below have 4¼" (108mm) gear housing outer diameter; Serial No. 1684188 and above have 4-3/4" (121mm) gear housing outer diameter.*

*** Serial No. 1776349 and above have an E-Z Shift gear housing.*

REMOVAL

1. Drain Super-Duty Gear Lubricant (C-92-52650) from gear housing by removing filler hole screw and vent screw (Figure 1) or oil vent screw from drive shaft housing for drives with interconnected oil chambers.

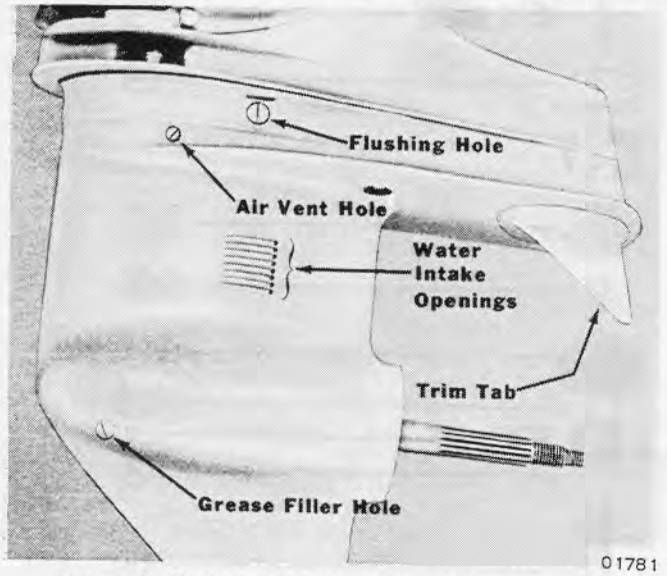


Figure 1. Draining Lubricant from Gear Housing

2. Place a block of wood between propeller and anti-cavitation plate to prevent propeller from turning while removing propeller nut.
3. Remove propeller by bending tabs on tab washer and removing propeller nut (right hand thread), tab washer, cupped thrust washer, propeller and thrust hub and washer assembly.
4. Remove three 5/8" hexagon head lock nuts which hold gear housing assembly to drive shaft housing (leading edge).
5. Remove two 5/8" hexagon head lock nuts which are located in center bottom side of anti-cavitation plate.
6. Remove trim tab under trailing edge of anti-cavitation plate by removing plastic plug and loosening socket head screw from rear top of drive shaft housing.
7. Remove allen head screw from inside trim tab cavity. (Models 60-80-90 have 9/16" nut.)
8. Separate gear housing from drive shaft housing and place in vise.
9. At this time, backlash between gears should be checked for future reference. Refer to "Checking Reverse Gear Backlash", following.

INSTALLATION

1. If water inlet tube was pulled out when gear housing was removed, coat tube upper end with New Multipurpose Lubricant (C-92-49588) so that it will slip easily into rubber seal in drive shaft housing.
2. Place light coat of New Multipurpose Lubricant on bottom end of water tube.
3. Apply heavy coat of New Multipurpose Lubricant on drive shaft splines.
4. Insert socket head trim tab screw in place on top of gear housing.
5. Check that shift control lever and lower unit are in forward gear before installing gear housing. Hold in forward gear by applying slight pressure to propeller shaft in counterclockwise direction.
6. Insert drive shaft into drive shaft housing, aligning water tube with water tube guide and drive shaft splines with upper drive shaft, then sliding into place while joining housings.

NOTE: Be careful that water inlet tube enters plastic water tube guide in water pump body recess and that rubber seal is in water pump cover. Oil passage "O" ring must be in position on gear housing with interconnected oil chambers.

7. Rotate propeller shaft to help drive shaft splines enter upper drive shaft splines. Upper and lower shift shaft splines also must be aligned.
8. With 2 housings joined, install and tighten elastic stop nuts and socket head screw.
9. Install trim tab and torque socket head screw to 180 in. lbs. (31.95kg/cm) thru hole in drive shaft housing, then replace plastic plug.

NOTE: Refer to trim tab adjustment in Section 1, "General Information".

WATER PUMP - MERCRUISER I-thru-165 and 888

DISASSEMBLY

1. Set gear housing in vise in upright position with skeg held between blocks of wood.
2. Remove "O" ring from upper end of drive shaft.
3. Remove centrifugal slinger from drive shaft.
4. Remove water pump body assembly by removing nuts and lockwashers, plus one cap screw and lockwasher.
5. Remove water pump body assembly, impeller, impeller drive pin, gaskets and face plate.
6. Check impeller and water pump insert closely for wear or damage.
7. Remove flushing screw, seal and gasket to allow water pump base assembly to be lifted out.

   NOTE: Flushing screw is not incorporated in later gear housings, and water pump base with flushing screw hole cannot be used on these later housings.
8. Remove "O" ring and oil seal from base plate assembly. (Figure 1)

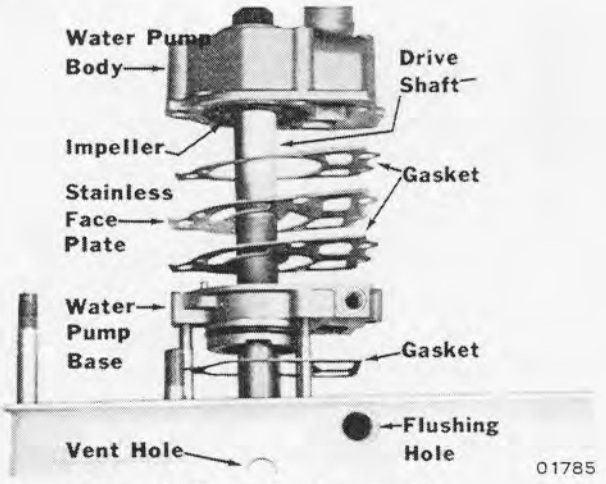


Figure 1. Water Pump Assembly

REASSEMBLY

1. Position water pump base assembly and gasket in gear housing.
2. Install water pump base-to-face-plate gasket and replace stainless face plate. (Figure 1)
3. If water pump impeller drive pin and impeller hub have worn excessively on drive shaft because of abrasion caused by silt and sand, a new impeller drive pin should be bonded to replacement drive shaft with Type "AV" Loctite (C-92-58295A1). Do not attempt to reuse a drive shaft that has worn down at this location. To install and bond replacement drive pin and drive shaft with Loctite, proceed as follows (if this condition does not exist, move on to Step 4, following):
   a. Place gear housing in vise so that drive shaft is horizontal.
   b. Using FRESH solvent (lacquer thinner is excellent) and a clean cloth, clean drive shaft from face plate up to end of spline. Also clean impeller insert and drive pin. Do not allow solvent to contact pump base oil seal. Wipe all cleaned surfaces dry.
   c. Rotate drive shaft so that the flat is up, Smear "AV" Loctite evenly on shaft section on which impeller will ride. With flat on shaft up, add more "AV" Loctite onto the flat.
   d. Roll drive pin in this puddle on the flat and leave it centered in flat.
   e. Slip impeller onto shaft with keyway up so that it will align with drive pin. Slowly push impeller down to the face plate.
   f. Rotate impeller back-and-forth several times, as far as drive pin will allow, to thoroughly wet impeller insert with Loctite.
   g. Wipe off any excess Loctite which appears above impeller.
   h. Proceed, beginning with Step 6, following.
4. Place drive pin on drive shaft, holding in position with dab of New Multipurpose Lubricant (C-92-49588).
5. Check condition of impeller closely and set in place over drive shaft.
6. Insert stainless water pump cartridge in water pump and place water pump body-to-face-plate gasket on water pump body. (Figure 1)
7. Slide water pump body assembly over drive shaft and impeller. (Figure 1)

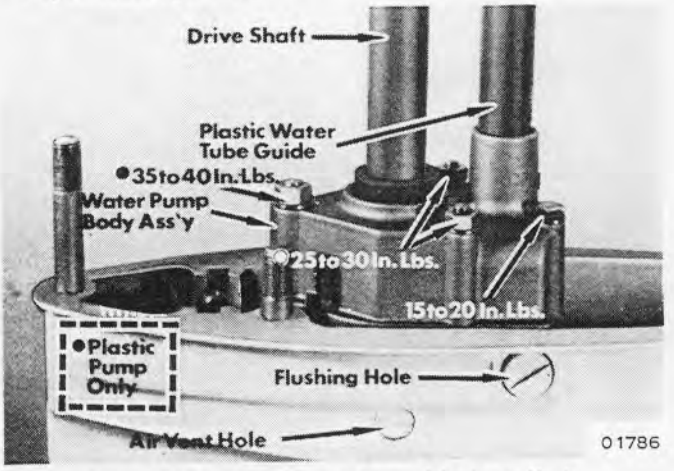


Figure 2. Water Pump Assembly Installed

8. Turn drive shaft clockwise and press water pump body assembly into place, at the same time seating impeller. Be sure that impeller drive pin is in position in drive pin groove of impeller.
9. Replace lockwashers and tighten nuts and cap screw.

   NOTE: Plastic water pump nuts and screws require specific torque values to prevent distortion and cracking of pump. (Figure 2)

10. Place plastic water tube guide in water pump body recess. (Figure 2)
11. Replace "O" ring and drive shaft slinger.
12. On gear housings with interconnected oil chambers, install "O" ring in recess with adhesive (C-92-25234).

NOTE: If Loctite is used in Step 3, above, allow gear housing to remain in horizontal position at room temperature or warmer (not to exceed 120° F) for 12 hours for Loctite to set. Gear housing assembly then can be reinstalled.

OIL and WATER ADAPTOR - MERCRUISER 60-80-90

DISASSEMBLY

1. Set gear housing in vise in upright position with skeg held between blocks of wood.
2. Remove plastic guide tube.
3. Remove oil and water adaptor assembly by removing nuts.
4. Remove "O" rings from oil and water adaptor assembly.

NOTE: See "Water Pump Replacement", preceding.

REASSEMBLY

1. Place 2 "O" rings, nylon washer, rubber bushing and gasket on oil and water adaptor.
2. Install oil and water adaptor in gear housing.
3. Place 3 nuts on oil and water adaptor studs and torque nuts to 144 in. lbs. (25.56kg/cm).
4. Place plastic water tube guide in water adaptor recess. (Figure 3)

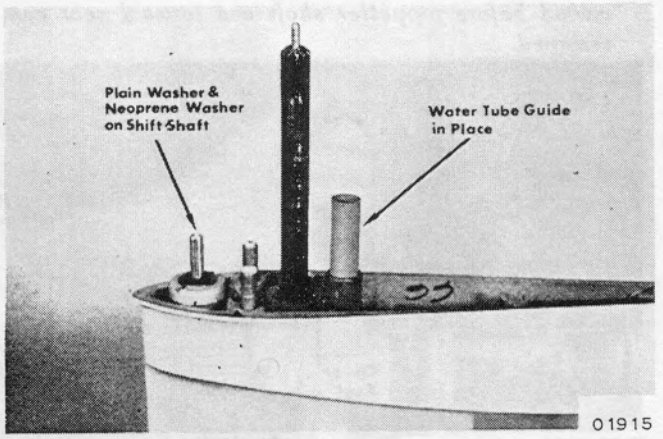


Figure 3. Water Tube Guide in Place - MerCruiser 60-80-90

BEARING CARRIER

REMOVAL and DISASSEMBLY

1. Bend lock tab of washer to uniock cover (later models only) and remove gear housing cover and tab washer with Gear Housing Cover Tool (C-91-53126 [Figure 4] or C-91-61069 [Figure 5]). Place tool over end of propeller shaft and set tool into cover, turning counterclockwise (right hand thread) to loosen. (Figure 4) If tight, strike handle of tool with mallet to loosen.

   NOTE: E-Z Shift propeller shaft cannot be removed at this time. Pinion gear and drive shaft must be removed before propeller shaft and forward gear can be removed.

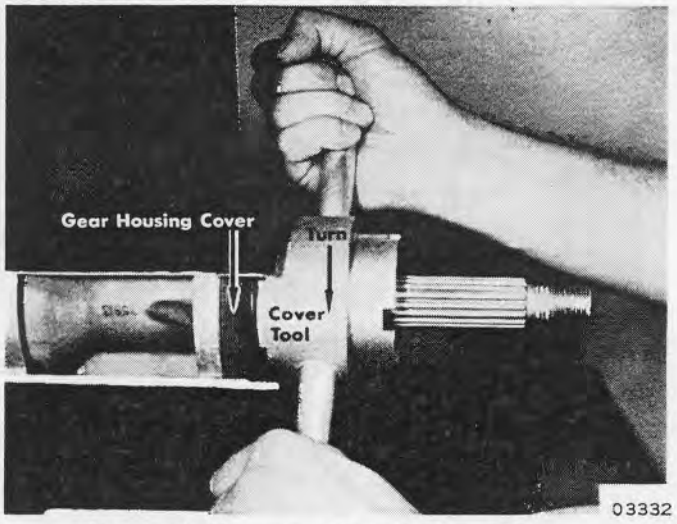


Figure 4. Removing Gear Housing Cover

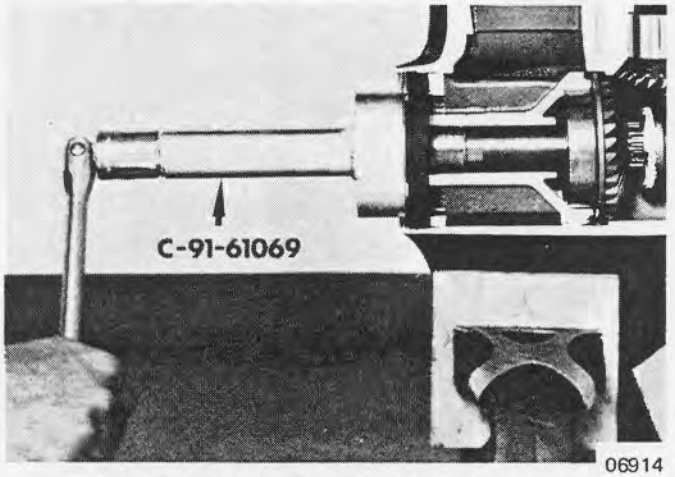


Figure 5. Removing Gear Housing Cover with Tool C-91-61069

2. The bearing carrier of E-Z Shift gear housing must be removed by catching ring of bearing carrier with Slide Hammer Puller (C-91-34569A1) with Jaws (C-91-34570) (Figure 6) or Puller (C-91-27780) and tapping outward with a mallet.

   Bearing carrier assembly of gear housing without E-Z Shift can be removed while removing propeller shaft. Place propeller shaft in vise between jaw protectors. Shaft assembly then can be removed by tapping lightly and evenly on skeg of gear housing with a mallet. Remove propeller shaft and key from keyway in bottom of bearing carrier.

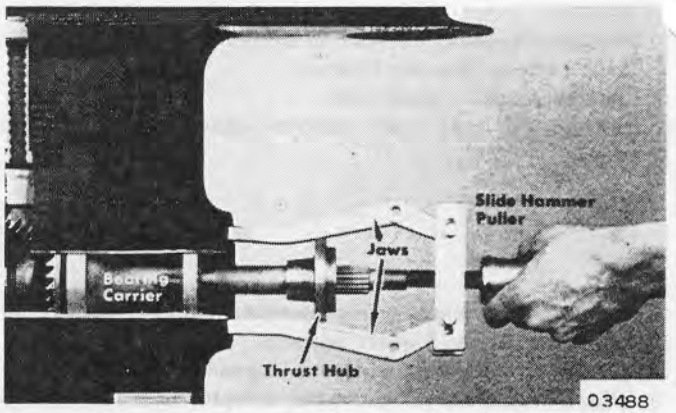


Figure 6. Removing Bearing Carrier

3. Remove shims which may adhere to bearing carrier or remain in gear housing.
4. Remove reverse gear from bearing carrier with tools listed in Step No. 2 immediately preceding. (Figure 7)

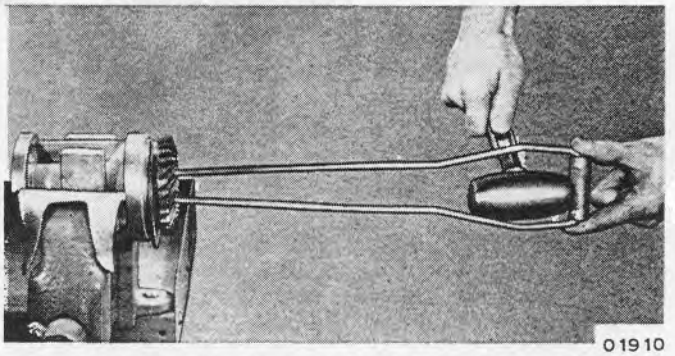


Figure 7. Removing Reverse Gear from Bearing Carrier

5. Remove "O" ring from carrier.
6. Press roller bearing and seals from carrier assembly with Drive Rod (C-91-37323) used in conjunction with an arbor press and Adaptor (C-91-37263). (Figure 8) (For "60" model, use Drive Head C-91-37311.)

   NOTE: Bearing Removal and Installation Set (C-91-31229A1) with Drive Head (C-91-37263) also may be used to pull bearing and oil seals. (Figure 9)

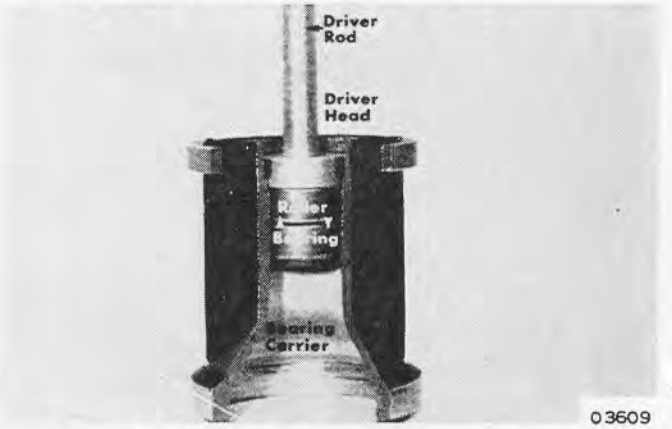


Figure 8. Pressing Roller Bearings from Carrier

7. Separate ball bearing from reverse gear assembly with Gear Puller Plate (C-91-37241). (Figure 10)

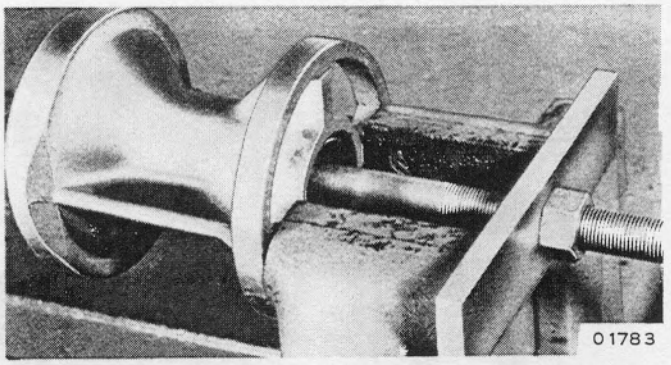


Figure 9. Pulling Roller Bearing and Oil Seals from Carrier

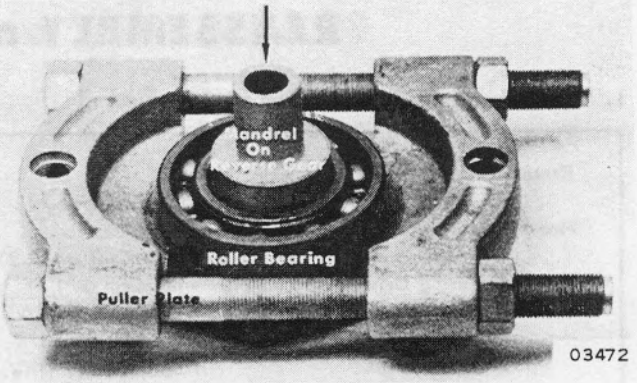


Figure 10. Removing Ball Bearing from Reverse Gear Assembly

REASSEMBLY and INSTALLATION

1. Press roller bearing into bearing carrier. (Figure 11)

Driver Head: C-91-37311* with Driver Rod	C-91-37323 - MerCruiser 60
Needle Bearing Adaptor: C-91-37363 w/Driver Rod	C-91-37323 - MerCruiser 80-90
Needle Bearing Driver: C-91-31109 - MerCruiser I Short End	IA-IB-IC, E-Z Shift, 120 and 160-165-888 (Fig. 11)

* *NOTE: Use Driver Head (C-91-37311) with Driver Rod (C-91-37323) to install MerCruiser 60 oil seals (first seal is spring-loaded).*

2. Install oil seals with Loctite Type "A" (C-92-32609) on outside diameter. Press first oil seal (lip in toward housing) with Oil Seal Driver (C-91-31108), seating on shoulder with deep end. (Figure 12) Use opposite end of tool to seat second seal with lip outward. (Figure 13)
3. Press large ball bearing with ball bearing thrust washer onto reverse gear. (Figure 14)

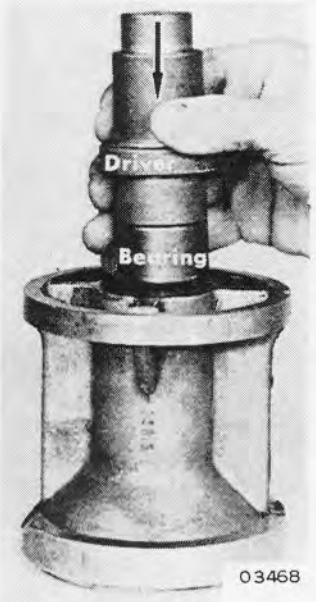


Figure 11. Carrier Bearing Installation

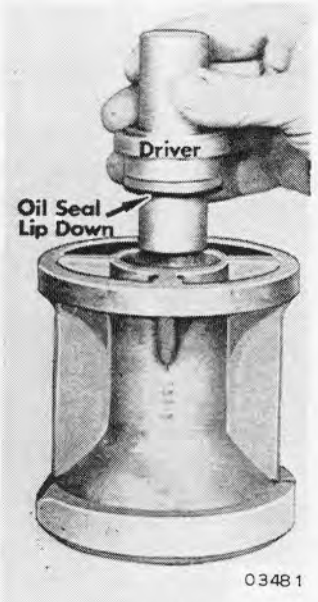


Figure 12. Carrier Seal Installation (Lip Downward)

4. Press reverse gear and ball bearing assembly into bearing carrier. Replace large "O" ring on outside diameter of bearing carrier.
5. Install shims in gear housing.

NOTE: On final installation of bearing carrier (after forward and reverse gear backlash has been corrected) apply Perfect Seal (C-92-34227) liberally to outer diameters of carrier spool. Surfaces must be clean and oil-free. DO NOT allow sealer to enter ball bearing or reverse gear. Also apply sealer to threads liberally in gear housing before installing retainer.

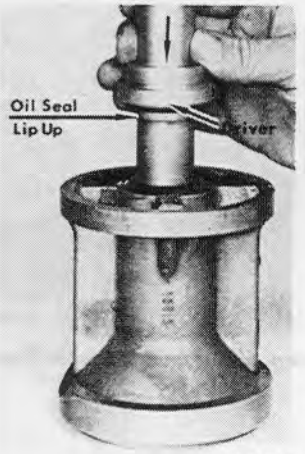


Figure 13. Carrier Seal Installation (Lip Upward)

Figure 14. Reassembling Reverse Gear

6. Push bearing carrier into gear housing with Sleeve (C-91-32699) on propeller shaft until it seats against ball bearing thrust ring. (Figure 15)

NOTE: Sleeve is not required for tapered propeller shafts.

7. Place key in keyway in bearing carrier and bottom of gear housing.
8. Coat threads of gear housing liberally with Perfect Seal (C-92-34227) to facilitate easy future removal of gear housing cover.
9. Place gear housing cover washer on bearing carrier shoulder. Later gear housings have tab washer for locking housing cover.
10. Thread gear housing cover onto gear housing and tighten in clockwise direction with Gear Housing Cover Tool (C-92-53126 or C-91-61009). Adaptor (C-91-59553) is placed on Cover Tool (C-91-53126) for applying proper torque to gear case cover nut when tightening cover nut. (See Section 8 "Specifications".)
11. Check forward and reverse gear backlash. Refer to "Checks", following.
12. After Step 11 is completed, refer to "NOTE", preceding Step 6, and repeat Steps 6-7-8-9 and 10.

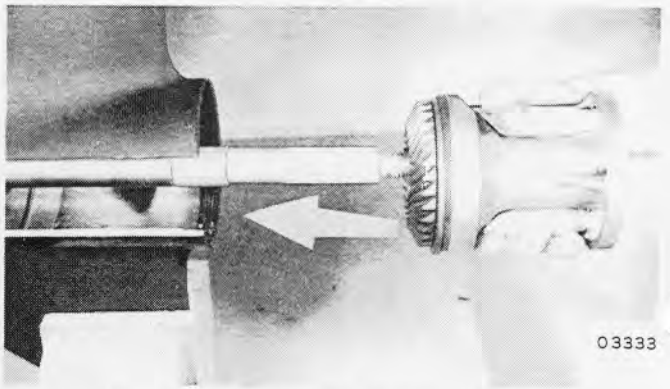


Figure 15. Bearing Carrier Installation

DRIVE SHAFT and SHIFT SHAFT
E-Z SHIFT DRIVE SHAFT REMOVAL

1. Place gear housing in vise (between blocks of soft wood) with propeller shaft facing up.
2. With a 7/8" open end wrench on pinion gear nut (Figure 1) or using Tool C-91-61067A1 (Figure 2), turn drive shaft counterclockwise with Drive Shaft torquing Tool (C-91-34377 or C-91-55775 for later models). (Figure 1)

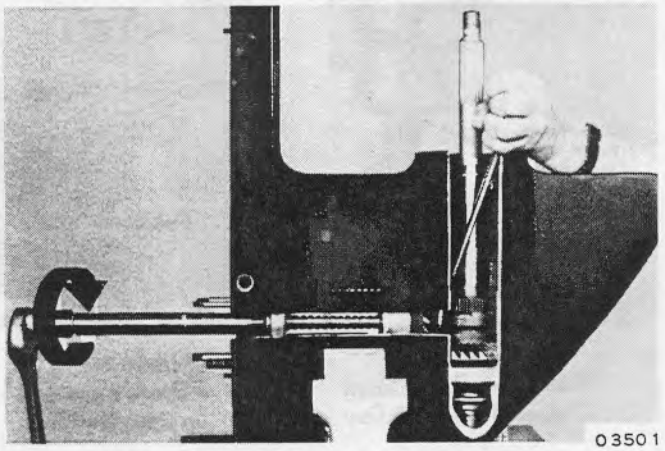


Figure 1. Loosening Pinion Gear Nut

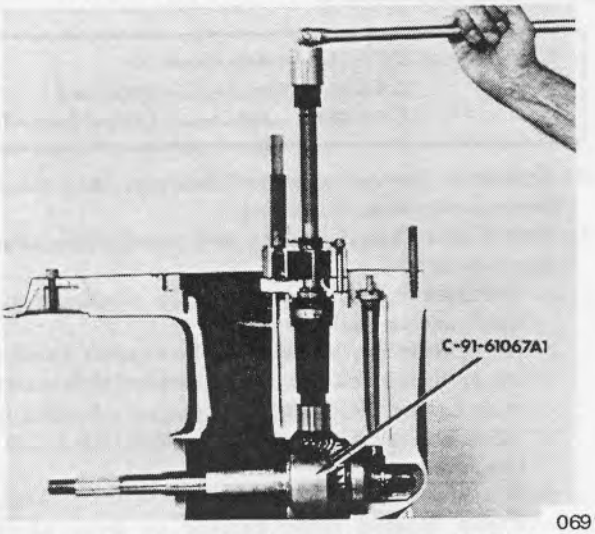


Figure 2. Loosening Pinion Gear Nut with Tool C-91-61067A1

3. With pinion gear nut removed, drive shaft assembly can be removed from gear housing. (Figure 3)
4. With drive shaft removed, propeller shaft, pinion gear and forward gear assembly can be removed from gear housing. When removing propeller shaft assembly, it is necessary to tilt shaft to left to disengage shift crank from spool.
5. Remove tapered roller bearing from drive shaft.
6. Remove drive shaft and forward gear tapered bearing cups from gear housing with Slide Hammer Puller (C-91-34569A1).

   NOTE: On some gear housings, it may be necessary to remove drive shaft tapered roller bearing cup, along with the lubricant recirculating device. See Step 8, following.
7. Look for shims under bearing cup.
8. If lubricant recirculating device is installed, place Sleeve Tool (C-91-39281) into grooves of sleeve (left hand thread) and thread end of Slide Hammer Puller (C-91-34569A1) into sleeve tool to remove it.

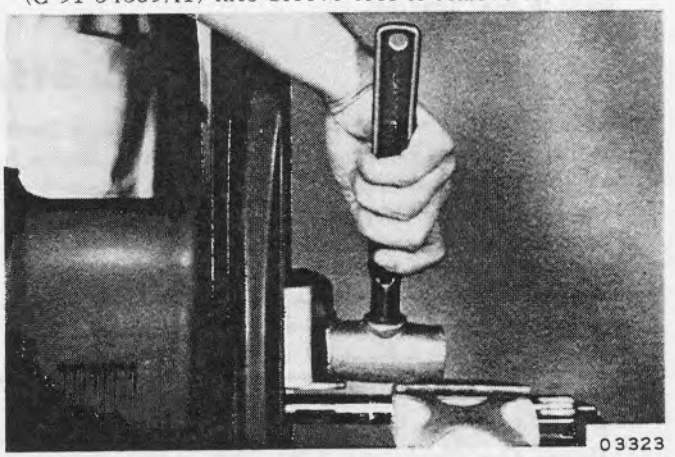


Figure 3. Removing Drive Shaft from Gear Housing

NOTE: Recirculating device is not required on gear housings with interconnected oil chambers.

9. Remove shift shaft bushing with Bushing Tool (C-91-31107) (Figure 4) and pull shift shaft out of gear housing. Shift crank then can be removed from housing.

NON - E-Z SHIFT DRIVE SHAFT REMOVAL

1. Place drive shaft in vise as close to gear housing as possible.
2. Remove nut (right hand thread) from drive shaft pinion gear with a thin box-end wrench.
3. Drive shaft can be lifted from gear housing.
4. On MerCruiser "60" and later MerCruiser I models, roller bearing is installed over lower end of drive shaft and is pressed against machined shoulder on drive shaft, therefore, remove by pressing from drive shaft. On MerCruiser "80-90", remove tapered roller bearing from drive shaft by placing drive shaft in vise and removing 1¼" nut (left hand thread) with suitable wrench. Remove snap ring on early MerCruiser I models. MerCruiser IA-IB-IC models have 1½" nut (right hand thread).
5. Remove drive shaft tapered bearing cup from gear housing with Slide Puller (C-91-34569A1). (Figure 4)
6. Remove forward gear and bearing assembly from gear housing. Remove gear from bearing with Universal Puller Plate (C-91-37241).
7. Remove forward gear housing cup from gear housing with Slide Hammer Puller (C-91-34569A1).
8. Remove shims which may adhere to bearing cup or remain in gear housing.
9. To remove and replace drive shaft roller bearing, refer to roller bearing replacement, following.

Figure 4. Removing Drive Shaft Tapered Bearing Cup

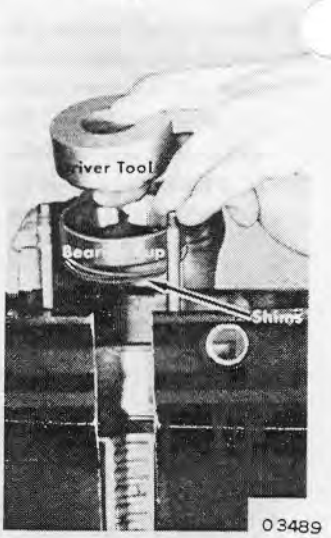


Figure 5. Drive Shaft Bearing - Cup Installation

DRIVE SHAFT REASSEMBLY

1. Replace shims which were removed originally from under drive shaft bearing cup. (Some drive shafts have ball bearing installed on drive shaft. Install shims when installing drive shaft, [Step 4A, following].) Place bearing cup on proper driver tool and press cup into housing. (Figure 5)

Driver Tool:	C-91-38918 - MerCruiser 60-80-90 C-91-34379 - MerCruiser 1-thru-165

2. Replace forward bearing cup with shims originally removed from gear housing. Place bearing cup on proper Driver Cup Tool (use following), and press or drive into housing, using Driver Rod (C-91-37323) with adaptor (C-91-37263) (Figure 6) or old propeller shaft.

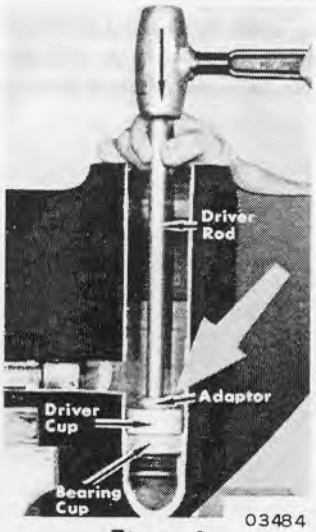


Figure 6. Forward Bearing Cup Installation

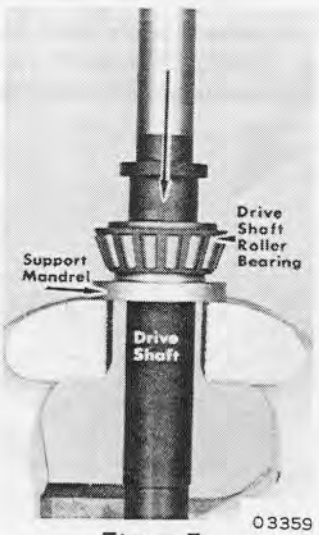


Figure 7. Installing Tapered Roller Bearing on Drive Shaft

Driver Cup:	C-91-31361 - MerCruiser 60 C-91-31106 - MerCruiser 80-90 and I C-91-36577 - MerCruiser IA-IB-IC-thru-165-888

3. Assemble forward gear and bearing, then place into bearing cup in gear housing.
4. Install drive shaft bearing and place drive shaft into gear housing.
   a. MerCruiser I (Early) - Place ball bearing on drive shaft and install snap ring.
   b. MerCruiser 80, 90 and I - Place tapered roller bearing on drive shaft and install lock nut (left hand thread) with Loctite (C-92-32609), torquing to 100 ft. lbs. (13.8mkg) (MerCruiser 80-90) or 160 ft. lbs. (22.1mkg) (MerCruiser I).
   c. MerCruiser 60, IA-IB-IC, E-Z Shift, 120-thru-165-Press tapered roller bearing on drive shaft from pinion end. (Figure 7)
5. Install pinion gear on drive shaft with pinion nut chamfer toward gear. Temporarily install pinion gear for E-Z Shift models. Non-E-Z Shift models are torqued at this time. (Figures 8 and 9)

   NOTE: Refer to "Drive Shaft, Shift Shaft and Component Replacement", preceding.
6. Shim pinion gear. Refer to "Checks", following for 120 thru 165 shimming tool.

Torque Values:	MerCruiser 60 model - to 50 ft. lbs. (6.9mkg) Non-E-Z Shift models - 60 ft. lbs. (8.3mkg) E-Z Shift models - 80 ft. lbs. (11mkg) with Grade A Loctite (C-92-32609)

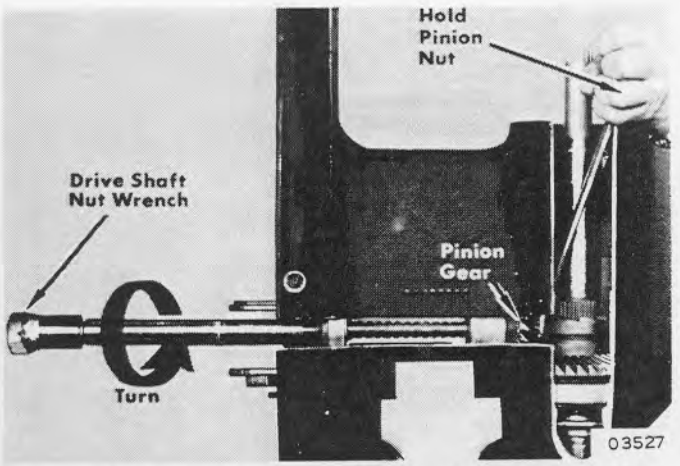


Figure 8. Tightening Pinion Gear Nut

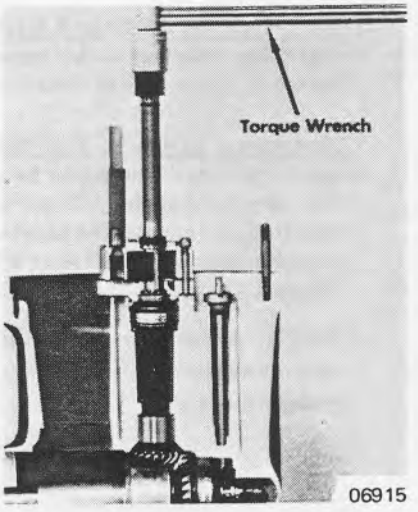


Figure 9. Tightening Pinion Gear Nut with Tool C-91-61067A1

ROLLER BEARINGS REMOVAL

1. Remove drive shaft roller bearings from gear housing with Driver Head (C-91-36569) and Driver Rod (C-91-37323). For MerCruiser "60", remove drive shaft roller bearing from gear housing with Driver Head (C-91-37312) and Driver Rod (C-91-37323). (Figure 1)
2. Place mandrel in drive shaft end of gear housing cavity.
3. Press bearing out with arbor press or tap on tool with heavy mallet to remove bearing. (Figure 1)

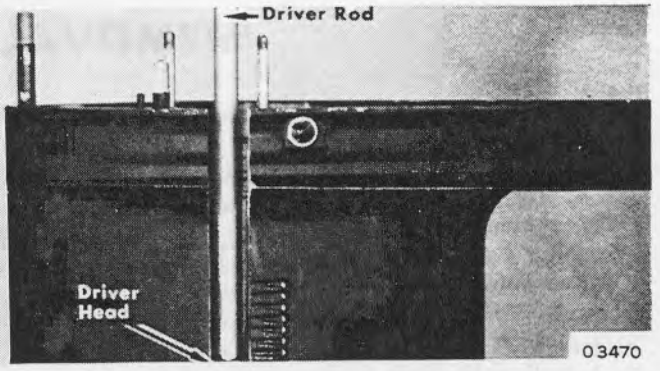


Figure 1. Removing Drive Shaft Roller Bearings

INSTALLATION

CAUTION: If a drive shaft roller bearing failure has occurred, replace gear housing assembly if bearing bore has been damaged or enlarged. It has been found that repeated failure can occur when original bearing turns in the gear housing, thus enlarging bearing bore surface to such an extent that new roller bearing will fit loosely and move out of position.

1. Install drive shaft bearing cartridge into gear housing with Puller Rod (C-91-31229), using proper Puller Head, or Driver Rod (C-91-37323) with washer (C-91-36571) and proper Driver Head from following chart. (Figure 2)

Driver Head:	C-91-37312* - MerCruiser 60
	C-91-36569* - MerCruiser 80-90 and I
Puller Head:	C-91-38628* - MerCruiser IA-IB-IC, E-Z Shift, 120-thru-165-888

NOTE: Install bearing cartridge so that numbered side faces up and away from pinion gear toward cavitation plate.

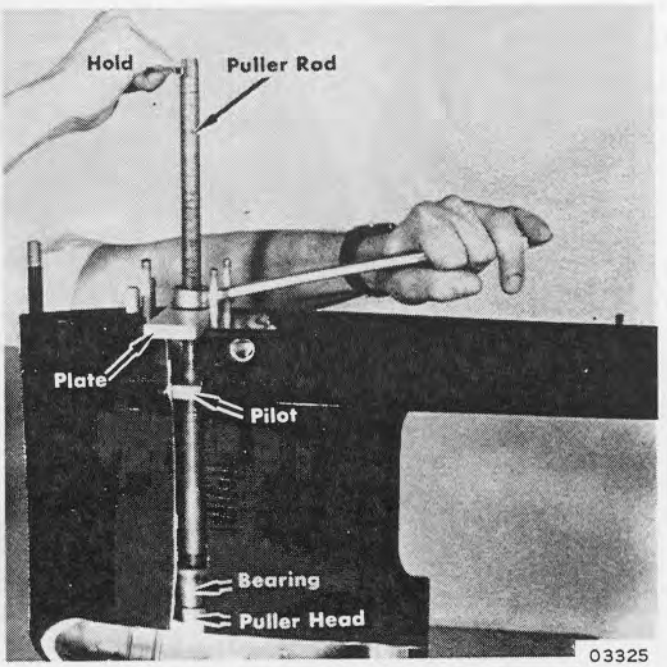


Figure 2. Installing Drive Shaft Bearing Cartridge

* *Part of Bearing Removal and Installation Kit (C-91-31229A4).*

2. MerCruiser 60-80-90 and Early MerCruiser I - Require cartridge bearing to be recessed evenly on shoulder between upper drive shaft cavity and lower cavity.

MerCruiser IA-IB-IC, E-Z Shift and 120-thru-165 - Require cartridge bearing to be recessed evenly on shoulder in gear housing. If an oil recirculating device is required, it is installed knurled end first into bore above pinion roller bearing, using a Wood Driver (C-91-39281). (Figure 3)

NOTE: MerCruiser 120-thru-165 drive units with interconnected oil chambers do not require a recirculating device.

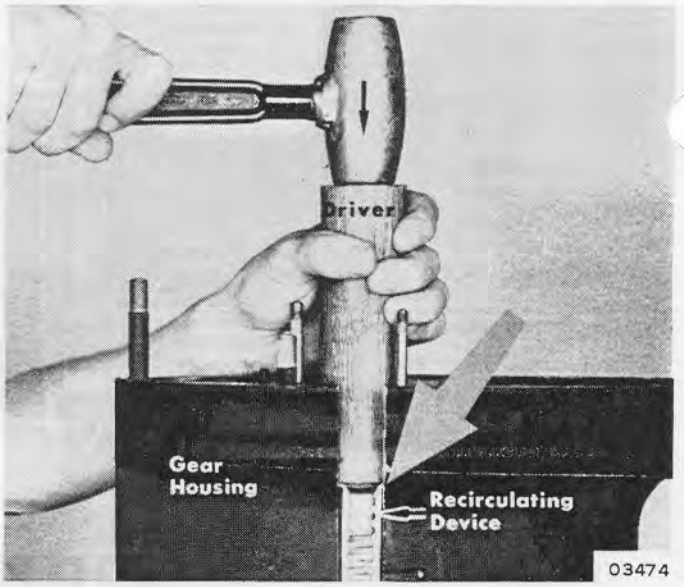


Figure 3. Installing Oil Recirculating Device

SHIFT SHAFT REMOVAL and REASSEMBLY

1. Remove shift shaft stop and flat washer or a rubber washer from shift shaft.
2. Remove shift shaft bushing, using Shift Shaft Bushing Tool (C-91-31107) (Figure 4) and pull shift shaft out of gear housing. (For MerCruiser "60", use C-91-23033 Bushing Tool.) Shifting cam or shift crank now is loose in gear housing and can be removed.
3. Install shifting cam with notches to the right.
4. Insert shift shaft with clip engaging cam spline.
5. Install shift shaft bushing and tighten securely with Shift Shaft Tool (C-91-31107) (C-91-23033 for MerCruiser "60"). (Figure 4)

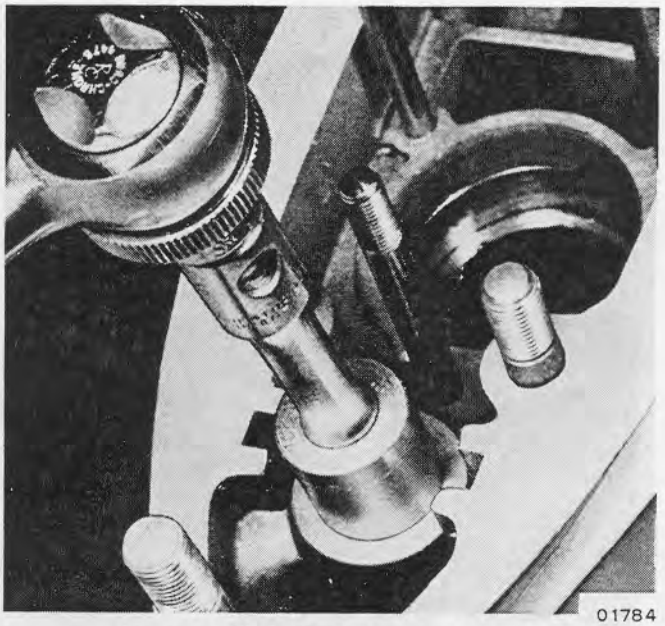


Figure 4. Shift Shaft Bushing Location

6. Turn shift shaft clockwise as far as it will go without forcing or until cam follower is felt against first notch on shift cam. This is forward gear.

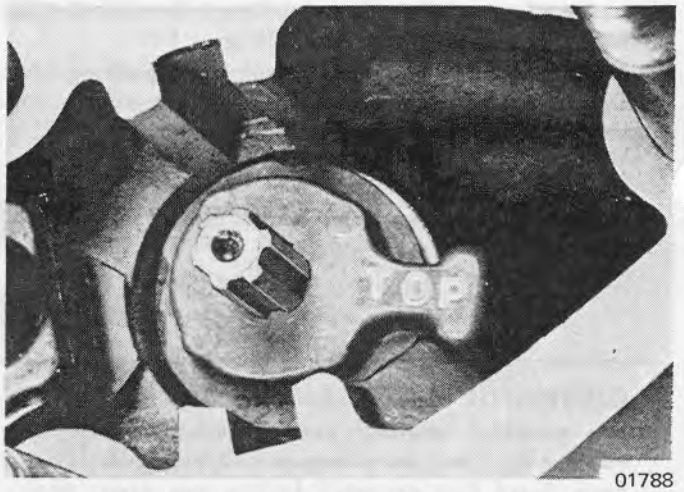


Figure 5 - Aligning Shift Shaft Stop on Shift Shaft

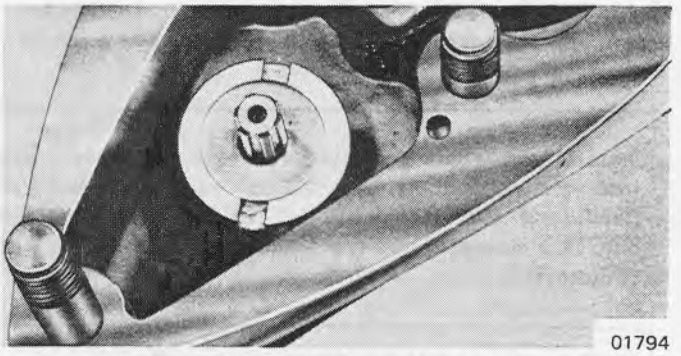


Figure 6. Plain Washer on Shift Shaft

NOTE: E-Z Shift gears can be shifted by turning shift shaft by hand, and no forcing is necessary.

7. With lower unit in forward gear, place shift shaft stop on shift shaft so that tang is facing forward and approximately 45° to right (starboard). (Figure 5) It is important

that lower unit is in forward gear and shift shaft stop is installed properly, or unit will not shift properly. (On MerCruiser I, 80-90 and later model gear housings, install neoprene and plain washer on shift shaft. (Figure 6)

8. After replacing shift shaft stop or plain washer, lubricate parts heavily with Multipurpose Lubricant (C-92-49588).
9. Join gear housing and drive shaft housing, preceding.

PROPELLER SHAFT - E-Z SHIFT MODELS

REMOVING PROPELLER SHAFT from GEAR HOUSING

NOTE: In order to remove the propeller shaft assembly, the bearing carrier must be removed, as instructed, preceding.

1. Remove water pump components, preceding.
2. Remove drive shaft components, preceding.
3. Tilt propeller shaft to the left, disengaging spool from shift crank in gear housing before lifting from housing.

DISASSEMBLY

1. Remove cotter pin from adjusting sleeve and unscrew sleeve with pliers.
2. Retainer, spool and forward gear assembly now can be removed from shaft.

NOTE: Remove tapered roller bearing from gear with Gear Puller Plate (C-91-37241).

3. Remove cross pin retaining spring and push cross pin out with a punch. Sliding clutch now can be removed from propeller shaft.

NOTE: Remove forward tapered bearing cup and shims with Slide Hammer Puller (C-91-34569A1), if replacement is necessary.

REASSEMBLY

NOTE: Only assemble propeller shaft after forward gear backlash has been checked, following.

1. Line up cross pin hole with slot in propeller shaft with groove toward reverse gear and install sliding clutch on propeller shaft.
2. Install clutch actuating shaft in propeller shaft, line up holes and install cross pin and retaining spring.
3. Slide forward gear assembly, spool, retainer, spring and washers onto propeller shaft.
4. Thread adjusting sleeve onto shaft until sleeve touches washer and slight resistance is felt. Back off sleeve until cotter pin slot is aligned with hole in shaft. Install cotter pin. (Figure 1)

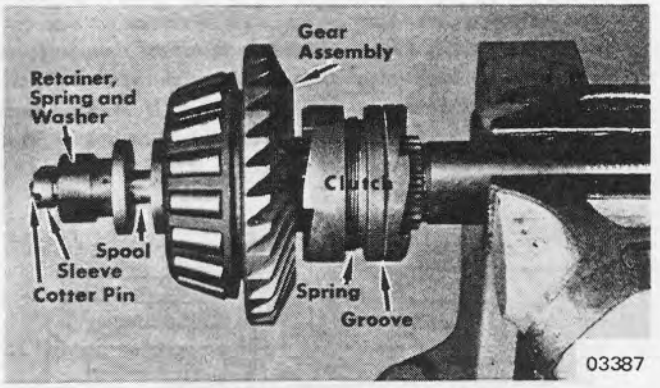


Figure 1. Assembling Propeller Shaft Components

REPLACING PROPELLER SHAFT and DRIVE SHAFT

1. Place propeller shaft and forward gear assembly into gear housing. Tilt shaft to left of gear housing to allow shift crank to engage into spool. (Figure 2)

NOTE: Be certain that forward gear bearing is seated into bearing cup and that crankshaft is engaged into spool. Check by turning lower shift shaft and notice free fore-and-aft movement of sliding clutch.

2. Install drive shaft and drive shaft tapered bearing into gear housing.
3. Install pinion gear on spline of drive shaft.

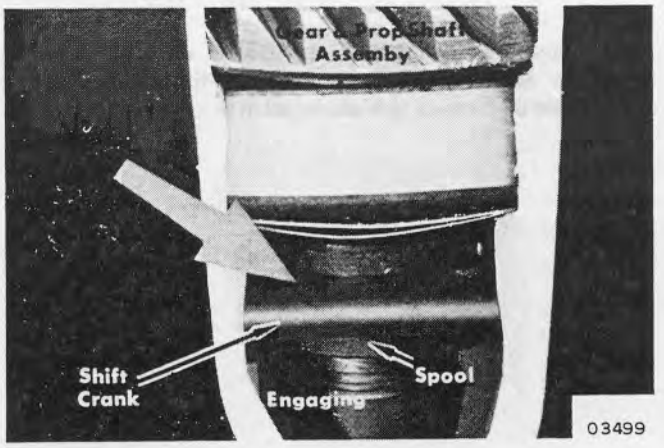


Figure 2. Spool and Shift Crank Engagement

4. Place a drop of Grade "A" Loctite (C-92-32609) on pinion gear nut threads and install nut. Torque to 80 ft. lbs. (11mkg) with Drive Shaft Torquing Tool (C-91-34337 or C-91-56775 for later models) holding pinion gear nut with 7/8" wrench or Tool C-91-61057A1. See "Drive Shaft Reassembly", preceding.
5. Refer to replacing bearing carrier preceding.

PROPELLER SHAFT - NON-E-Z SHIFT

REMOVING PROPELLER SHAFT from GEAR HOUSINGS

The propeller shaft is removed with the bearing carrier, preceding.

DISASSEMBLY

1. Use screwdriver to detach retaining ring from sliding clutch. Do not over-stretch so that ring will not lose its shape and tension.
2. Remove sliding clutch from propeller shaft by pressing against cam follower and, with small punch, push cross pin out of sliding clutch.
3. Sliding clutch now is free to be removed from propeller shaft. Cross pin will slide and spring will drop free from inside of propeller shaft.

REASSEMBLY

1. Install cam follower spring and cam follower slide inside hollow end of propeller shaft so that holes in cam follower slide match hole in propeller shaft.

   NOTE: On MerCruiser I-IA-IB-IC, place 3 washers, new spring, cross pin slide and follower inside propeller shaft. Measure distance from top of cam follower to end of propeller shaft. Distance must be 25/64" (10mm), plus-or-minus 1/64" (.4mm). If measurement taken is not within tolerance, add or subtract washers under follower spring as required. Each washer is 1/32" (.8mm) thick. (Figure 3)

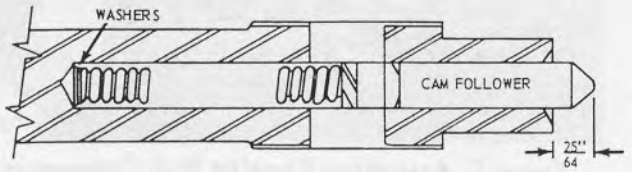


Figure 3. Washer Placement

2. Place sliding clutch (Figure 4) onto propeller shaft and install cam follower in end of propeller shaft.
   NOTE: If clutch teeth are copper-coated, install coating toward forward gear.
3. Compress spring inside propeller shaft by pressing on cam follower until holes in sliding clutch, propeller shaft and cross pin slide all line up.
4. Place cross pin thru sliding clutch, propeller shaft and slide.
5. Install cross pin retaining spring around sliding clutch. Do not over-stretch spring when installing.
6. Place propeller shaft assembly into forward gear assembly in gear housing.
7. Refer to replacing bearing carrier, preceding.

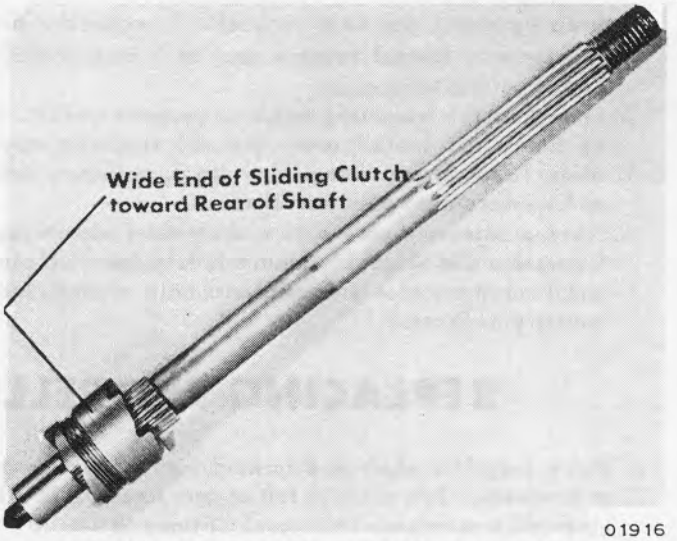


Figure 4. Installing Sliding Clutch - MerCruiser "60"

PINION GEAR SHIMMING

1. Install pinion gear on drive shaft in gear housing.
2. Position shimming tool in gear housing.
3. Check for .025" (.635mm) between gear and tool while applying inward pressure on drive shaft to seat its roller bearing. (Figure 5)

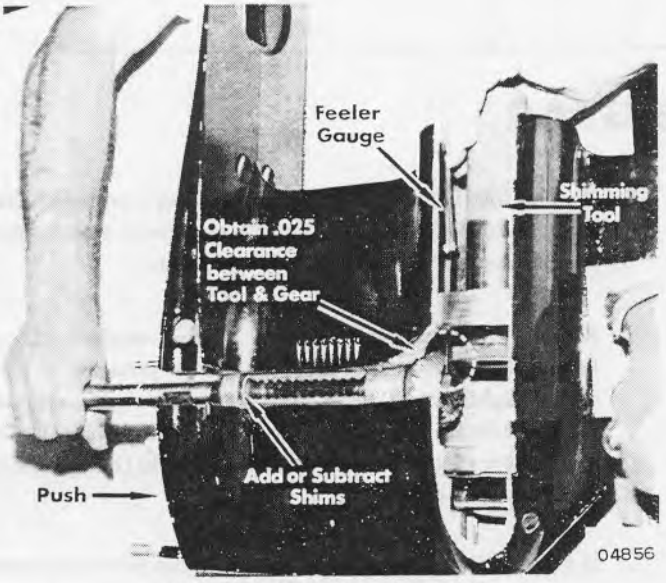


Figure 5. Shimming Procedure

4. If clearance is incorrect, remove pinion gear and drive shaft. Remove bearing cup from housing and add or subtract shims to obtain .025";i.e., if over .015", remove shims from under bearing cup, if under .025", add shims under bearing cup.
5. If clearance is correct, reassemble gear housing.

NOTES: 1. The Pinion Gear Shimming Tool for MerCruiser 90-120-140-160-165-888 models accurately positions pinion gear in gear housing and eliminates misalignment of gear mesh (not clearance) between pinion gear and forward and reverse gears.

Select from the following:

C-91-56050 Pinion Shimming Tool - 90 Model
C-91-56048 Pinion Shimming Tool-120-140-160-165-888

NOTES: 2. Shimming tool for MerCr. 120-140-160-165 model gear housings may be used in earlier gear housings which have a late pinion gear (B-43-55812) installed.

3. MerCr. 90 shimming tool may be used in MerCr. 80 gear housings which have pinion gear B-43-55425 installed. Late pinion gears have a ground, flat surface on tips of gear teeth.

GEAR BACKLASH CHECK FORWARD GEAR

NOTE: Gear housing must be assembled to check gear backlash. It is not necessary to have water pump installed.

1. Turn drive shaft clockwise several turns to align rollers in bearings. Fasten dial indicator to gear housing and Backlash Indicator Rod (C-91-53459) to drive shaft. (Figure 6)

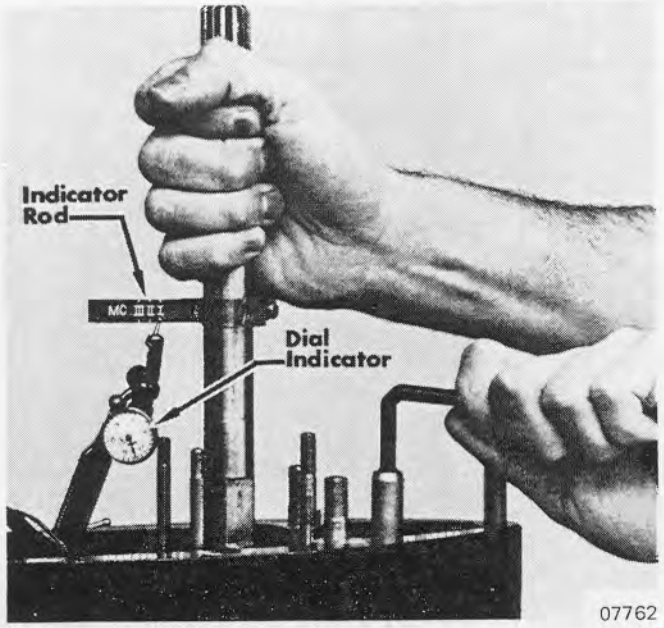


Figure 6. Checking Gear Backlash

2. Shift gear housing into full forward. Turn drive shaft clockwise to ensure full engagement of sliding clutch.
3. Watch shift shaft movement. Slowly turn propeller shaft clockwise until shift shaft movement stops. Apply pressure on shift shaft toward forward gear.
4. Position dial indicator pointer to line marked "I" on backlash indicator rod. Hold downward pressure on drive shaft. Lightly turn shaft and pinion gear assembly back-and-forth. DO NOT turn propeller shaft. Dial indicator registers amount of backlash. (Figure 6) (See following chart for specifications.)
5. If backlash is less than required, remove shims from forward gear bearing race. If backlash is more than required, add shims to forward gear bearing race.

NOTE: Both forward and reverse gear backlash should be checked at one time so that changing of shims in either gear may be completed in one take-down procedure.

GEAR BACKLASH

Model	MerCruiser 60-80-90	MerCruiser I-A-B-C-120-140-160-165, Serial No. 3443920 and Below	MerCruiser 888 and 120-140-165, Serial No. 3469428 and Up
Forward Gear	.006" to .008"	.006" to .008"	.010" to .012"
Reverse Gear	.006" to .008"	.015" to .020"	.020" to .025"

REVERSE GEAR

NOTE: Gear housing must be assembled to check gear backlash. It is not necessary to have water pump installed.

1. Turn drive shaft clockwise several turns to align rollers in bearings. Fasten dial indicator to gear housing and Backlash Indicator Rod (C-91-53459) to drive shaft. (Figure 6)
2. Shift gear housing into full reverse. Turn drive shaft clockwise to ensure full engagement of sliding clutch.

NOTE: On models MerCruiser I and IA-IB-IC without E-Z shift, disregard Step 3 and complete the following: Shift into full reverse and turn propeller shaft until sliding clutch dog engages with reverse gear clutch dog. Now shift to neutral gear and turn propeller shaft ¼" in same direction. Apply pressure on shift shaft toward reverse gear. Proceed with Step 4.

3. Watch shift shaft movement. Slowly turn propeller shaft counterclockwise until shift shaft movement stops. Apply pressure on shift shaft toward reverse gear.

4. Position dial indicator pointer to line marked "I" on backlash indicator rod. Hold downward pressure on drive shaft. Lightly turn drive shaft and pinion gear assembly back-and-forth. DO NOT turn propeller shaft. Dial indicator registers amount of backlash. (Figure 6) (See preceding chart for specifications.)

5. If backlash is less than required, add shims between reverse gear thrust washer and gear housing. If backlash is more than required, remove shims.

DRIVE SHAFT HOUSING

REMOVAL

1. Shift unit into forward gear.
2. Remove following, if so equipped.

   a. Remove elastic stop nuts and washers from tilt adjustment or anchor studs and aft anchor pin to remove hydraulic cylinders and tilt adjustment stud.

   b. Remove bolt, which secures dyna shocks to drive shaft housing (Figure 1) and place reverse lock hook release lever in "Release" position.

3. Remove elastic stop nuts (or cap screws) which secure drive shaft housing to bell housing.
4. Remove drive shaft housing by pulling straight back. (Figure 2)

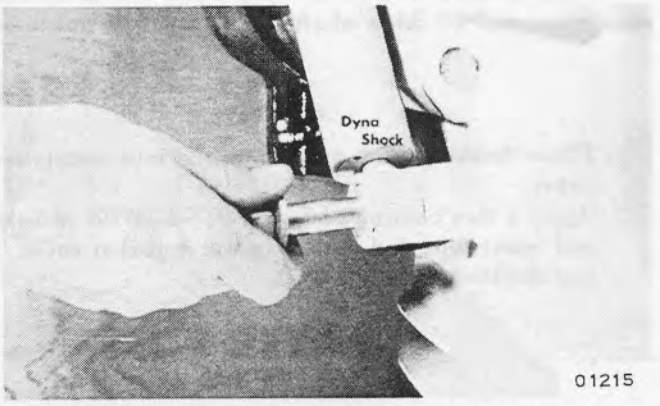


Figure 1. Removing Dyna Shocks - MerCruiser I

INSTALLATION

NOTE: Check engine and gimbal bearing alignment and gaskets before installing drive unit.

For installation of drive unit to bell housing, reverse the removal procedure.

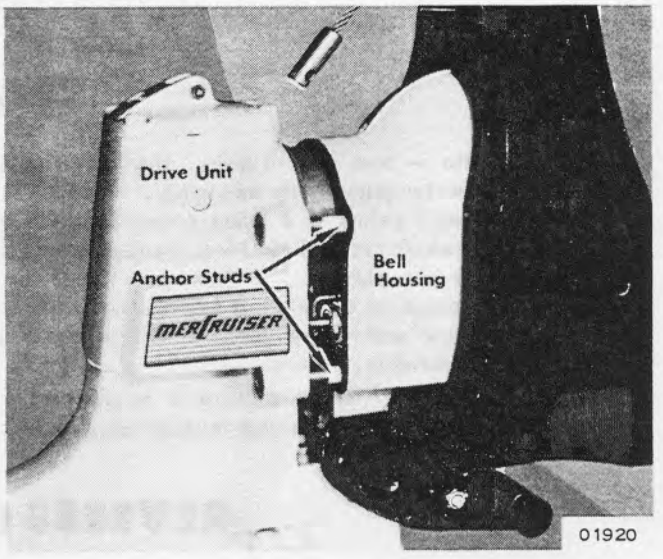


Figure 2. Removing Drive Shaft Housing - MerCruiser 60-80-90

TOP COVER

1. Remove 4 screws which hold top cover assembly to drive shaft housing.
2. Remove top cover assembly by lifting and twisting cover slightly. (Figure 3)
3. Install top cover assembly by reversing removal procedure, above.

   NOTE: Late MerCruiser 120-thru-165 and 888 have a Belleville washer under bearing cup for upper shaft preload. Use New Multipurpose Lubricant to hold washer in place when reinstalling cover. If washer is out of position, it will cause excessive bearing preload.

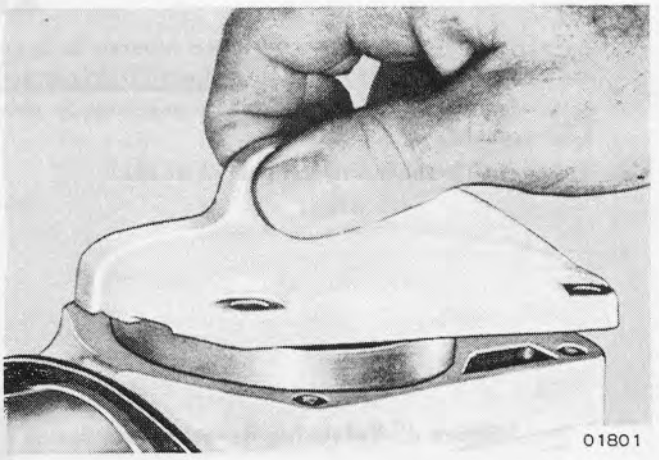


Figure 3. Removing Top Cover

WATER POCKET COVER

REMOVAL

1. Remove screws from water pocket and cover inside lower end of drive shaft housing and pull out cover and water tube.
2. Remove water tube, bushing and nylon washer.

REASSEMBLY

1. Place bushing and nylon washer into water pocket cover.
2. Apply a thin coating of Sealer (C-92-33749) on bushing and water tube and install in water pocket cover. Follow directions in sealer kit.

NOTE: MerCruiser 60 water tube is 6" (15.24cm) in length and 80-90 water tube is 5" (12.7cm) in length.

3. Place gasket on water pocket cover and install cover.
4. Torque screws to 12 ft. lbs. (1.5mkg).

WATER PUMP - MERCRUISER 60-80-90

REMOVAL

1. Remove top cover assembly, gasket, face plate, impeller, drive pin and water pump cartridge insert.
2. Remove screws which hold water pump body. Remove "O" rings from water inlet and outlet orifices in housing.
3. Remove "O" ring and press 2 seals and bearing cup from body with Oil Seal and Bearing Tool (C-91-31108).

REASSEMBLY

1. Install seals -- one with lip up, the other with lip down -- in water pump body assembly.
2. Install original shims and bearing cup in pump body. Check drive shaft preload (following under reassembly), if pump body is replaced.
3. Place "O" rings on drive shaft housing water inlet and outlet orifices and place rubber "O" ring on water pump body assembly.
   NOTE: Late model units require a small gasket installed in water pump housing to seal around locating tab on insert.
4. Install water pump body assembly in drive shaft housing and torque screws to 5-8 in. lbs. (.9-1.4rg/cm).
5. Using Anti-Corrosion Grease (C-92-45134), place water pump insert into water pump body.
6. Place impeller drive pin on impeller shaft, holding pin in position with New Multipurpose Lubricant (C-92-49588).
7. Install impeller over drive pin and place gasket, face plate and gasket over top of water pump assembly.
8. Install top cover and torque to 20 ft. lbs. (2.8mkg).

REVERSE LOCK ASSEMBLY

MERCRUISER 60-80-90

REMOVAL

1. On early MerCruiser 60's, release reverse lock spring and drive out pin. (Figure 4) On later 60 drives and all 80's, drive out reverse lock pin and remove reverse lock assembly.
2. Remove shift shaft nut and pull shift shaft.

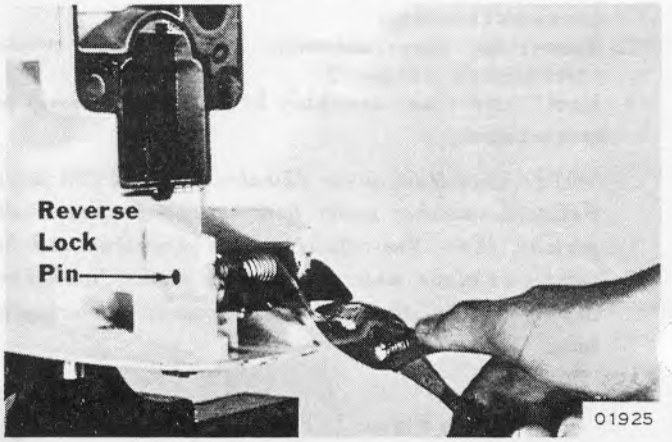


Figure 4. Releasing Reverse Lock Spring

REASSEMBLY

1. Install reverse lock assembly, springs and shift shaft.
2. Install reverse lock pin and engage springs.
3. Install nut on shift shaft.
4. Install water shutter into exhaust outlet. (Figures 5 and 6)

MERCRUISER I-thru-165 and 888

REMOVAL

NOTE: Power Trim models do not require reverse lock assembly.

1. Remove reverse lock stop screw, spring and washer. (Figure 7)
2. Remove reverse lock pivoting screw.
3. Remove cotter pin and washer from upper shift shaft, then remove shift shaft.
4. Remove reverse lock assembly.

REASSEMBLY

1. Install reverse lock assembly and upper shift shaft. Place thin coat of New Multipurpose Lubricant (C-92-49588) on cam and nylon roller.
2. Install reverse lock pivot screw and nut and tighten securely.
3. Install washer and cotter pin on upper shift shaft.
4. Install reverse lock stop screw, spring and washer. Washer and spring are under reverse lock assembly. (Figure 7)

Figure 5. Reverse Lock and Water Shutter Locations - MerCr. 60

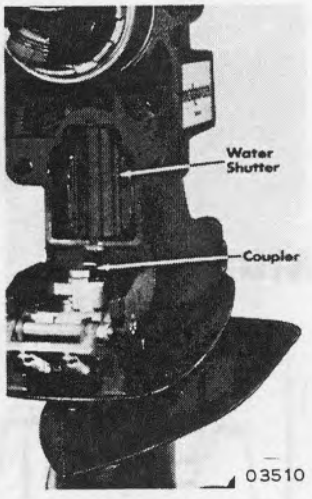


Figure 6. Reverse Lock and Water Shutter Locations - MerCr. 80-90

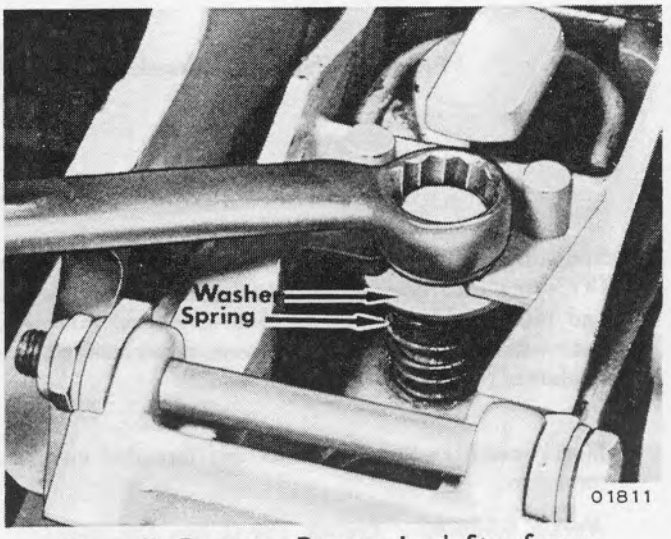


Figure 7. Removing Reverse Lock Stop Screw

UNIVERSAL JOINT SHAFT GEAR and BEARINGS

REMOVAL

1. Remove threaded cover with spanner wrench (right hand thread) selected from the following chart: (Figure 2)

Spanner Wrench	
MerCruiser 60-80-90	*- C-91-38378*
MerCruiser I	*- C-91-32822*
MerCr. IA-IB-IC, E-Z Shift, 120-140-160-165-888	*C-91-36235*

2. Remove universal joint and drive shaft assembly by pulling straight out.
3. Check for shims which may adhere to bearing cartridge and/or to shoulder in drive shaft housing.

Figure 1. Removing Threaded Cover

REASSEMBLY

1. Slide drive gear, universal joint assembly, shims and "O" ring into drive shaft housing. On MerCruiser IC and 160-165 drives only, to align universal joint shaft gear with drive shaft gear, remove cover assembly as explained, following. (Figure 1 and 2)

2. Install stainless steel washer and threaded cover and torque to:

   MerCr. 60-80-90 : Approx. 150 ft. lbs. (20.7mkg)
   MerCr. 1-thru-165: Approx. 200 ft. lbs. (27.6mkg)

3. Install top cover in MerCruiser IC 160-165 drive shaft housing, preceding.

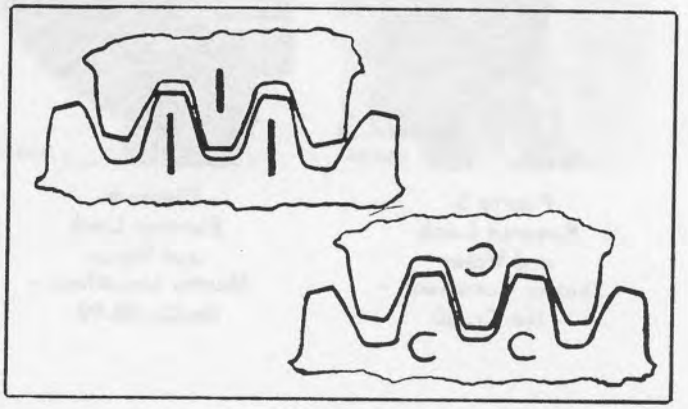


Figure 2. MerCruiser 160-165 Gear (Left) and IC (Right)

CROSS BEARING REMOVAL and REASSEMBLY

1. Remove threaded cover with Spanner Wrench from following chart.

Spanner Wrench	
MerCruiser 60-80-90	*- C-91-38378*
MerCruiser I	*- C-91-32822*
MerCr. IA-IB-IC, E-Z Shift, 120-140-160-165-888	*- C-91-36235*

2. Position Universal Joint Tool with Adaptor (C-91-38756) on cross bearing and tighten pressure screw until lock ring can be removed. (Figure 3) Universal joint or tool may be damaged if tool is not properly centered.

3. Reverse tool and press other bearing until lock ring can be removed.

4. Continue to press until opposite bearing is free, then repeat this procedure on other bearings.

5. In the case of a "stubborn" bearing, it may be necessary to give the pressure screw a sharp tap with a hammer, while it is under pressure, to start the pressing operation.

6. To reassemble, reverse order of preceding procedure.

NOTE: Refer to "Lubrication" Section 1C for lubrication.

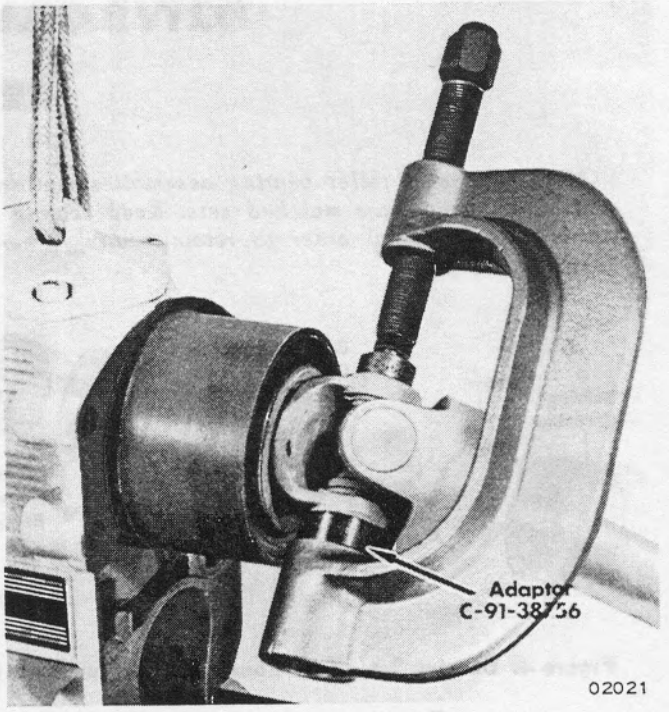


Figure 3. Removing Lock Ring

DRIVE GEAR and BEARINGS

REMOVAL

NOTE: Tapered roller bearing assemblies and drive and pinion gear are matched sets. Keep bearing assembly in original order to retain bearing preload. (Figures 4 and 5)

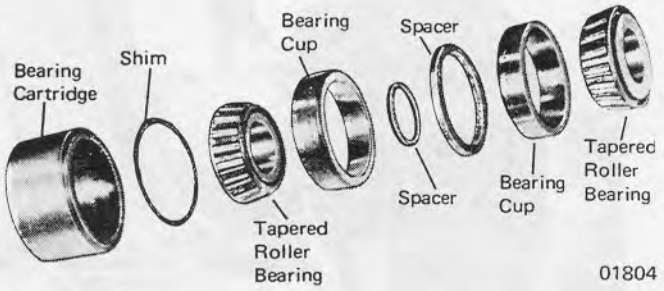


Figure 4. Bearing Set - "U" Joint - MerCruiser I (Early)

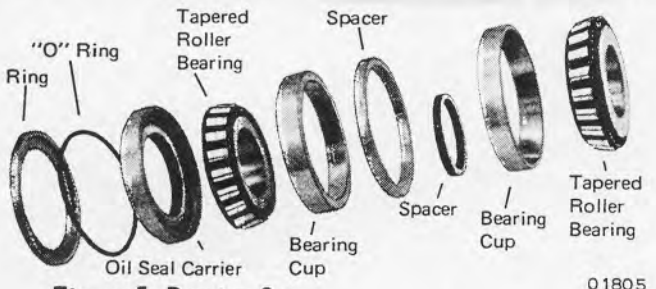


Figure 5. Bearing Set - "U" Joint - MerCruiser I-thru-165 and 888

1. Clamp metal bar in vise and place universal joint on bar. (Figure 6)
2. Remove drive nut and washer (right hand thread).
3. Remove drive gear and bearing assemblies or cartridge from shaft. On MerCruiser I, press out tapered roller bearings by supporting outside of bearing cartridge. (Figure 7)
4. Remove spacer, tapered roller bearing and oil seal carrier from shaft.

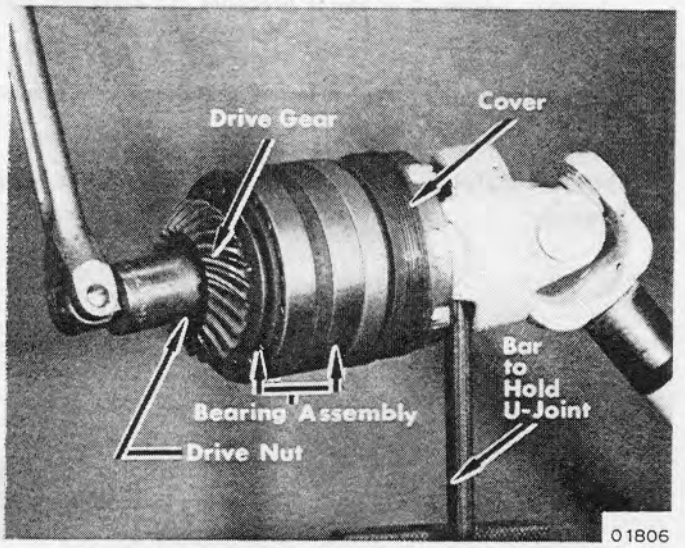


Figure 6. Removing "U" Joint Shaft Drive Nut

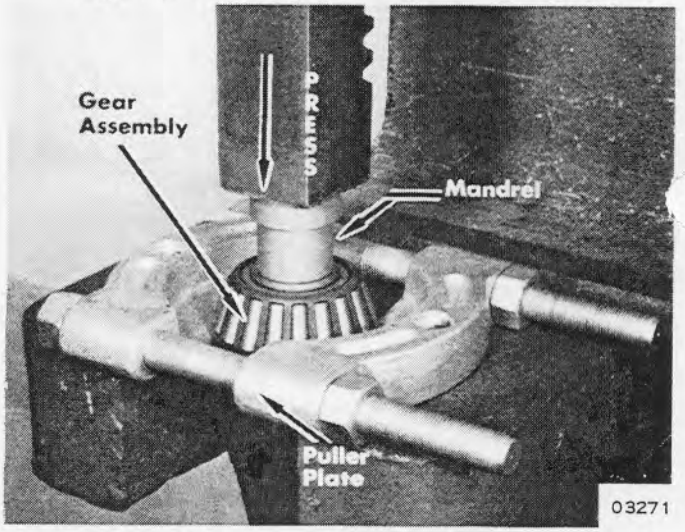


Figure 7. Pressing Bearing from Gear - MerCr. 1-thru-165

CAUTION: Drive gear and pinion gear are a matched set. If replacement is required, they must be replaced as a set. Tapered roller bearings, matching cups and spacers, which are assembled in drive gear bearing cartridge, must be replaced in sets so that bearings will have correct amount of preload when assembled.

REASSEMBLY (MERCRUISER 60-80-90)

1. Place Loctite (C-92-32609) on outer diameter of carrier oil seal, then press it into seal carrier with lip toward tapered roller bearing.
2. Place bearings and spacer on drive gear in following order: Tapered bearing (with large diameter toward gear), tapered bearing cup, cone spacer, bearing cup (with large diameter up) and tapered bearing in cup. (Figure 8)

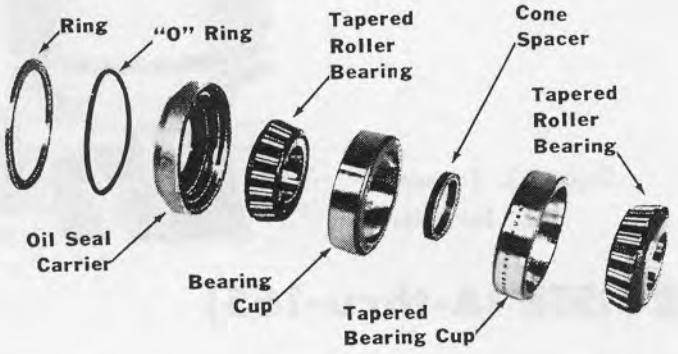


Figure 8. Drive Gear Components

3. Place bearing cup into oil seal carrier.

   NOTE: This is normally a hand fit but, if tight, bearing cup can be pressed into oil seal carrier.

4. Clamp metal bar in vise and place universal joint on bar.
5. Place steel thrust washer and "O" ring on universal joint shaft.
6. Place oil seal carrier assembly on universal joint shaft with lips facing up.

   NOTE: Place Multipurpose Lubricant (C-92-49588) on oil seal lips before placing assembly on shaft.

7. Place gear and bearing assembly on universal joint shaft.
8. Place drive gear and washer (bowed side away from gear) on universal joint shaft and torque nut to 50 ft. lbs. (6.913mkg). (Figure 9)

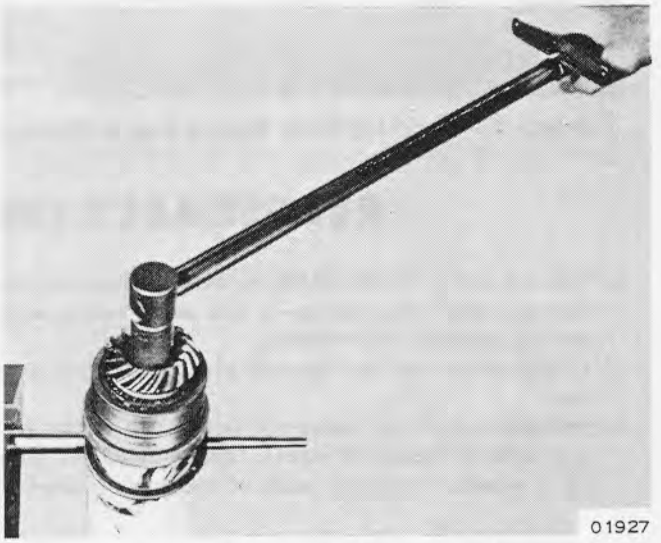


Figure 9. Torquing "U" Joint Nut

REASSEMBLY (MERCRUISER I)

1. Place Loctite (C-92-32609) on outside diameter of carrier oil seal, then press it into seal carrier with lip toward tapered roller bearing.
2. Install original shims, if any, in bearing cartridge.
3. Place bearings and spacers on bearing cartridge in following order: Tapered roller bearing with large diameter toward shoulder in bearing cartridge, tapered bearing cup over roller, cone spacer, large spacer, bearing cup with large diameter up and tapered roller bearing in cup.
4. Press bearings and spacers into cartridge until bearing bottoms on shims in bearing cartridge. (Figure 10)
5. Outer bearing cup should extend .002"-.004" (.05-1.1mm) above edge of cartridge. Add or remove shims under bottom bearing cup to achieve this dimension. (Figure 11)
5. Clamp metal bar in vise and place universal joint on bar.
7. Place oil seal carrier assembly on universal joint shaft with lips facing up.
8. Place tapered roller bearing, spacer and complete bearing cartridge assembly on universal joint shaft.
9. Place drive gear and washer (bowed side away from gear) on universal joint shaft and torque nut to 70-80 ft. lbs. (9.66-11.04mkg). (Figure 12)

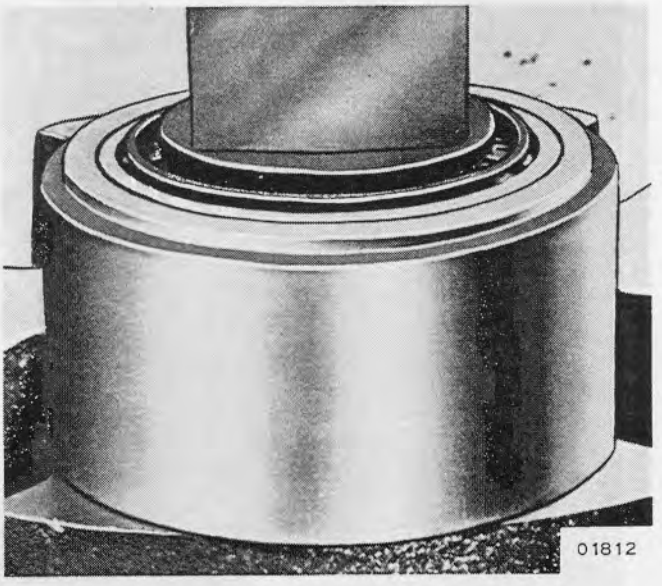


Figure 10.
Pressing Bearings, Cup and Spacer

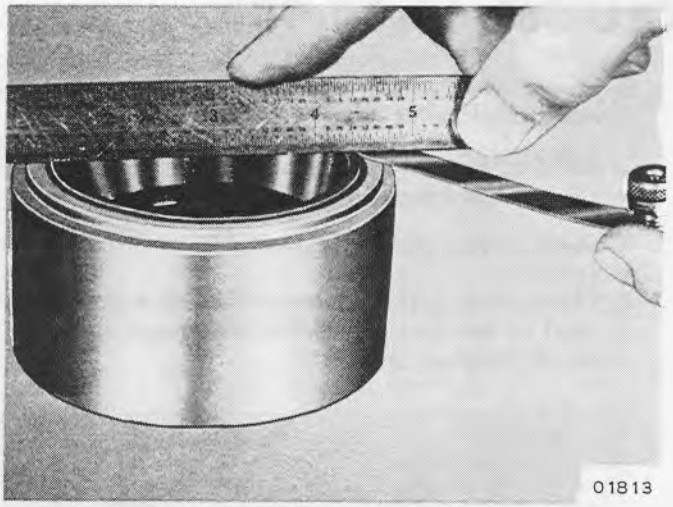


Figure 11. Checking Outer Bearing Cup in Retainer

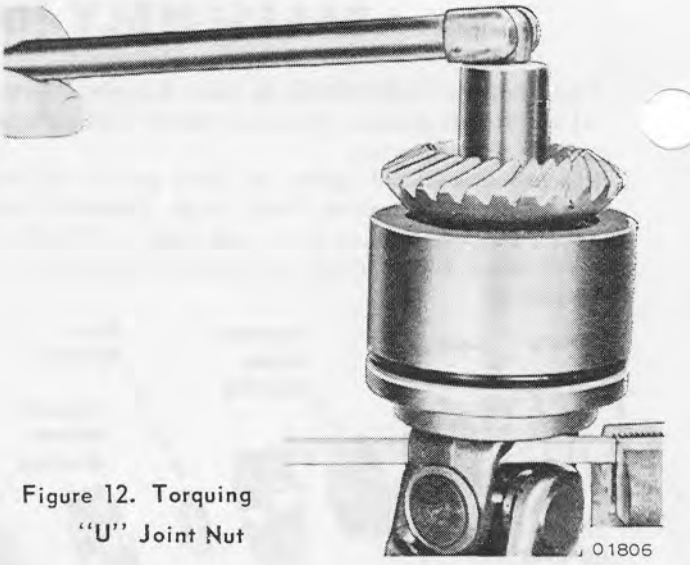


Figure 12. Torquing "U" Joint Nut

REASSEMBLY (MERCRUISER IA-thru-165)

1. Place Loctite (C-92-32609) on outside diameter of carrier oil seal, then press it into seal carrier with lip toward tapered roller bearing.
2. Clamp metal bar in vise and place universal joint on bar.
3. Assemble parts on universal joint shaft in the following order: Threaded cover, stainless steel washer, "L" washer with flat surface toward universal joint, oil seal carrier with "O" ring toward "L" washer, tapered roller bearing with large diameter toward oil seal carrier, tapered bearing cup over roller, cone spacer, large spacer, bearing cup with small diameter toward spacer and tapered roller bearing in cup.
4. Place drive gear and washer (bowed side away from gear) on universal joint shaft and torque nut to 70-80 ft. lbs. (9.66-11.04mkg).

UPPER DRIVE SHAFT, GEAR and BEARING REMOVAL (Early 60-thru-165)

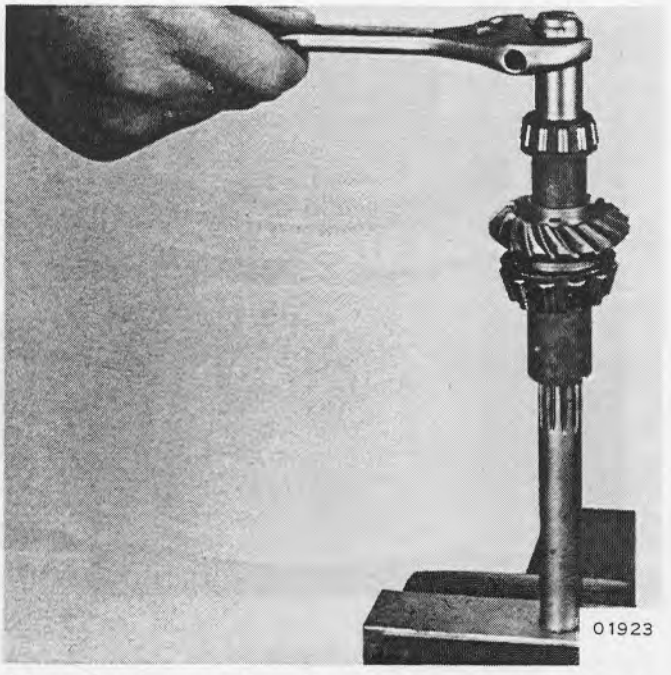


Figure 1. Removing Impeller Shaft from 60-80-90 Models

1. Remove universal joint, preceding.
2. Lift drive shaft from drive shaft housing.
3. Place upper drive shaft assembly in powerhead stand, following:

Powerhead Stand

MerCruiser 60-80-90 - C-91-25821A1
MerCr. 1-thru-165 - C-91-30591A1

NOTE: Stand is not required for late 120-thru 165.

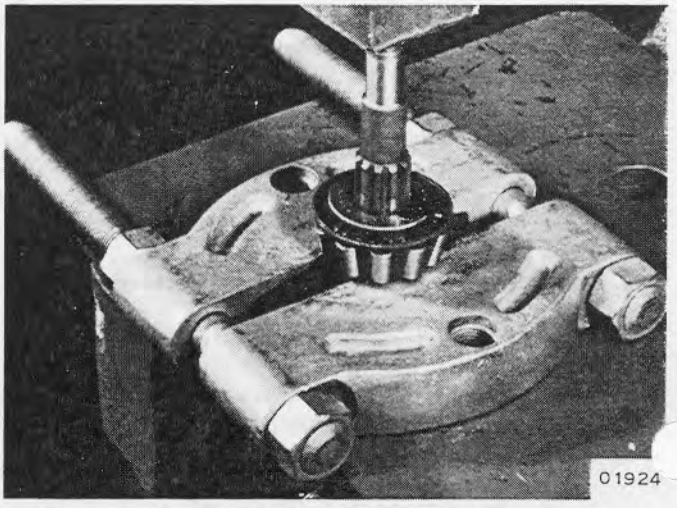


Figure 2. Pressing Roller Bearing from Upper Drive Shaft Assembly on 60-80-90 Models

4. On 60-80 and 90 models, remove impeller shaft (left hand thread). (Figure 1) On 1-thru-160 models, remove nut (right hand thread). Washer, tapered roller bearing, spacer and gear (assembly) can be lifted from upper drive shaft.
5. On 60-80 and 90, press roller from upper drive shaft assembly. On 1-thru-165, press roller bearing from gear assembly. Use Puller Plate (C-91-32337A1). (Figure 2)
6. Use Slide Hammer Puller (C-91-34569A1) with Jaws (C-91-46086A1) to remove lower bearing cup. On I-thru-165 models, then remove oil seals.

REMOVAL

(120-thru-888 with Pressed-On Gear)

1. Using Universal Puller Plate C-91-37241, place upper drive shaft assembly on arbor press and remove pinion gear bearing assembly. (Figure 3)
2. With Universal Puller Plate (C-91-37241) placed under upper drive shaft bearing and, using an appropriate tool, press bearing from drive shaft on an arbor press. (Figure 4)
3. Support pinion gear and press upper drive shaft from pinion gear with appropriate tools.

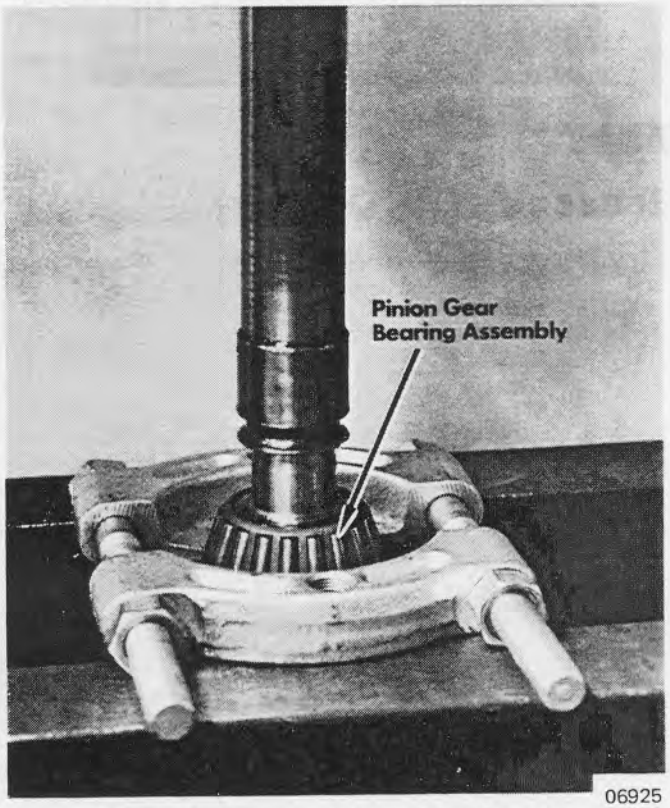


Figure 3. Removing Pinion Gear Bearing

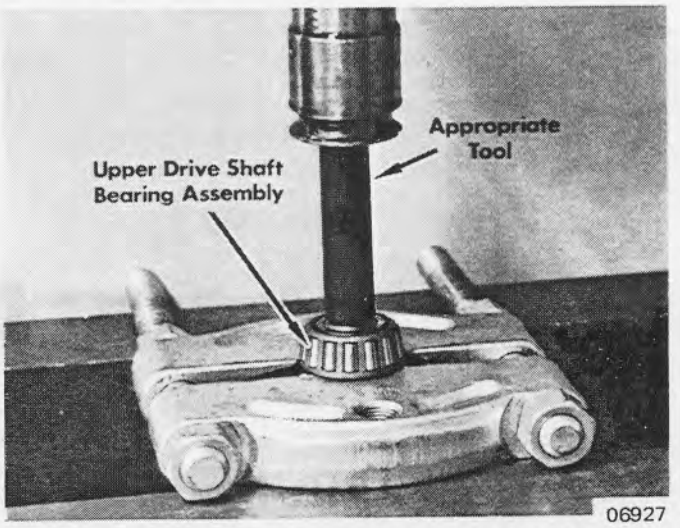


Figure 4. Removing Upper Drive Shaft Bearing

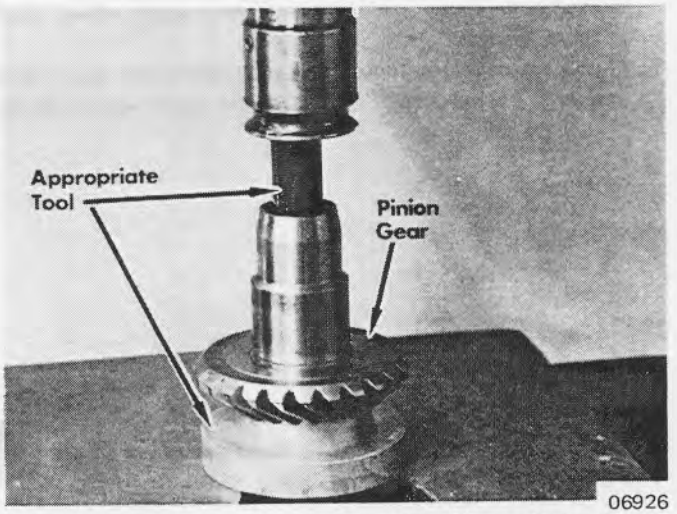


Figure 5. Removing Pinion Gear from Upper Drive Shaft

REASSEMBLY (MerCruiser 60-80-90)

1. Place upper drive shaft in Powerhead Stand (C-91-25821A1).
2. Place tapered roller bearing on upper drive shaft.
3. Place pinion gear, spacer, small tapered roller bearing and impeller shaft on upper drive shaft and torque to 40 ft. lbs. (5.52mkg). (Figure 6)

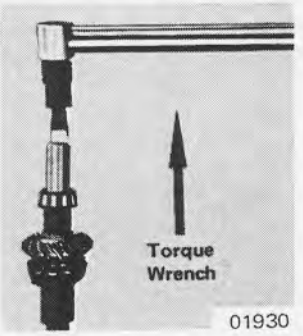


Figure 6. Torquing Impeller Shaft-MerCruiser 60-80 and 90

1. Place upper drive shaft in Powerhead Stand (C-91-30591A1).
2. Press tapered roller bearing on pinion gear.
3. Place pinion gear, spacer, small tapered roller bearing and washer (bowed side away from gear) and torque nut to 85 ft. lbs. (11.73mkg). (Figure 7)

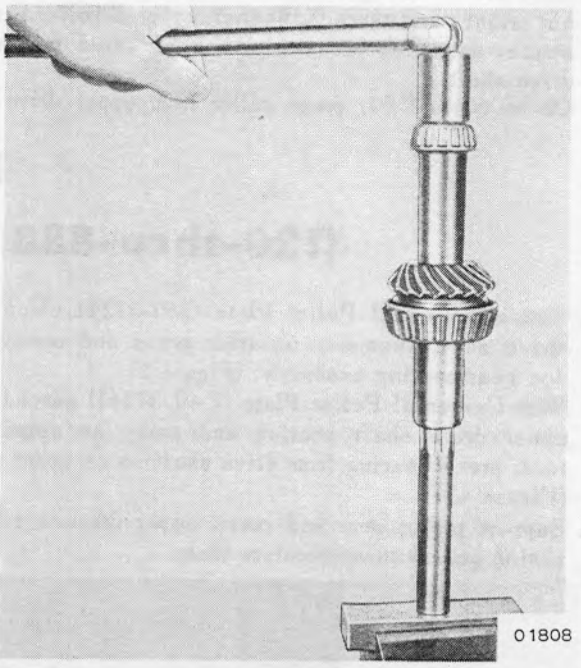


Figure 7. Torquing Upper Drive Shaft Nut-MerCruiser I-thru-165

REASSEMBLY
(120-thru-888 with Pressed-On Gear)

1. Make sure that "O" ring is in place on upper drive shaft, then press pinion gear onto upper drive shaft. (Figure 8)
2. Using appropriate tools, press upper drive shaft bearing and pinion gear bearing onto upper drive shaft.

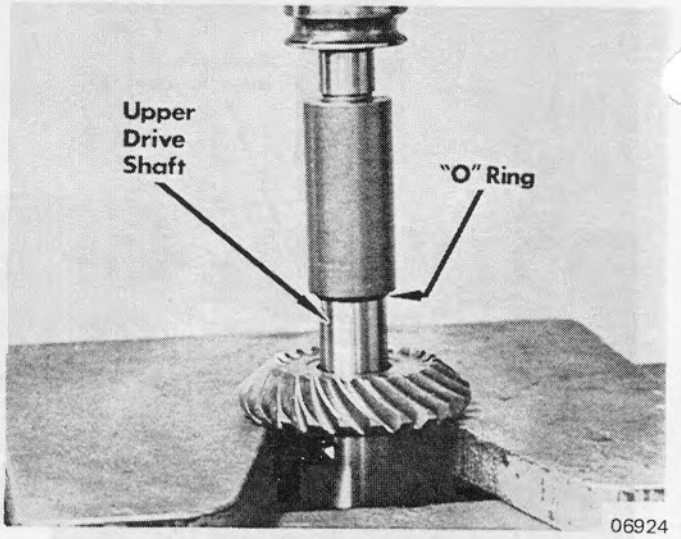


Figure 8. Pressing Pinion Gear onto Drive Shaft

OIL SEAL INSTALLATION

1. Use Loctite Type "A" (C-92-32609) and press lower (small) oil seal into housing from gear housing side, flush with housing and with seal lips toward oil chamber.
2. Press upper (larger) oil seal into housing thru oil chamber with lips toward oil chamber with tool (C-91-33490).

SHIMMING DRIVE GEAR and UNIVERSAL JOINT SHAFT

NOTE: When shimming MerCruiser 120 and 140 drive units (Serial No. 2791956 and above), disregard hole marked "120" or "X" in Pinion Shimming Tool (C-91-45878) and use hole marked "160" or "Y". The later 120-140 pinion gear has its measuring surface in the same position as the 160-165 pinion gear.

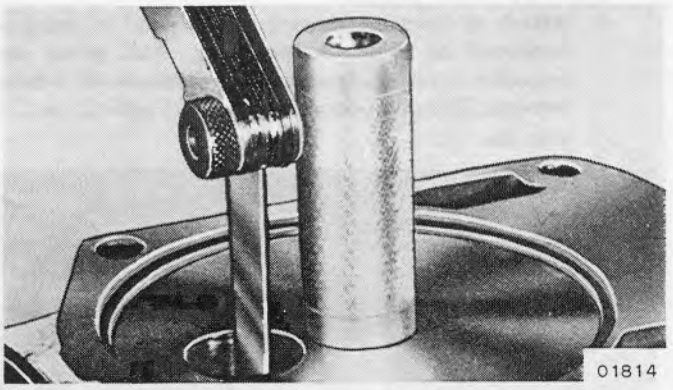


Figure 9. Measuring Drive Gear Clearance-1-60-80-90

NOTE: When using Tool C-91-60523, perform "Driven Gear Shimming" before shimming drive gear. When using Shimming Tool C-91-60523, vertical drive shaft may remain installed when checking driving gear clearance. Tool is placed into drive housing over tapered roller bearing with letter "Z" toward driving gear for MerCruiser 888, letter "X" for MerCruiser 120-140 (Serial Nos. below 2791956) and letter "Y" for MerCruiser 160-165 and MerCruiser 120-140-drive units (Serial No. 2791956 and above).

Pinion Shimming Tools (Driving Gear)

MerCruiser 60-80-90	*- C-91-36763*
MerCruiser I	*- C-91-33487*
MerCr. I-IA-IB-IC	*- C-91-36385*
MerCr. 120-140-165	*- C-91-45877*
(See "NOTE" at top of this page.)	
MerCr. 120-140-165-888	*- C-91-60523*
(See "NOTE" directly above.)	

1. Clamp drive shaft housing in vise between 2 blocks of soft wood.
2. Install original shims in drive shaft housing.
3. Place Drive Gear Shimming Tool (from chart below, left) into drive shaft housing thru top cover opening.
4. Apply a light coat of Multipurpose Lubricant (C-92-49588) to outside of bearing cartridge and slide complete assembly into drive shaft housing.
5. Install stainless steel washer and threaded cover. Tighten cover securely, observing torque, following:

   MerCr. 60-80-90 : Approx. 150 ft. lbs. (20.7mkg)
   MerCr. I-thru-165 and 888: Approx. 200 ft. lbs. (27.6mkg)
6. Measure gap between flat surface of drive gear and face of tool with feeler gauge. (Figures 9 and 10)
7. For correct gear mating, gap between tool surface and gear tooth must be exactly .025" (.64mm).
8. Add or subtract shims between bearing cartridge and drive shaft housing to achieve proper gap. Threaded cover must be tightened after any change in shimming.
9. After proper clearance between tool and gear has been attained, remove shimming tool and universal joint shaft assembly.
10. Set assembly aside, being careful not to damage shims.
11. MerCruiser I: Place rubber "O" ring around bearing cartridge.

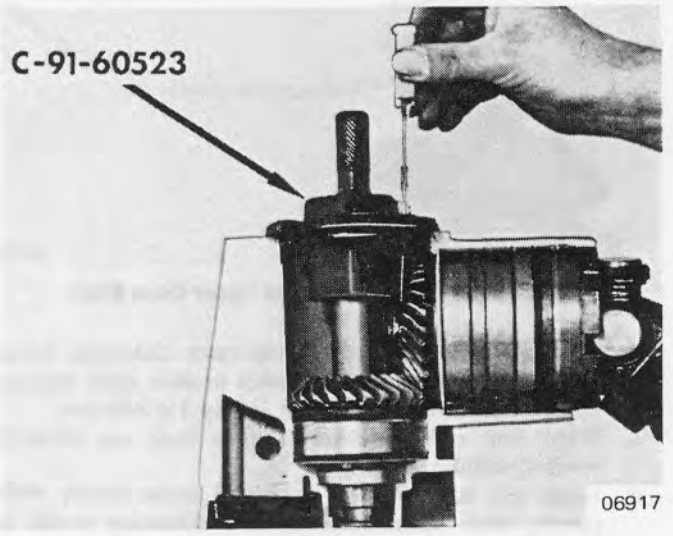


Figure 10. Measuring Drive Gear Clearance 120-140-160-165-888

DETERMINING UPPER DRIVE SHAFT PRELOAD

NOTE: Some model 120-thru-888 drive shaft housings have a bellville washer under the cop cover bearing race, which automatically determines the drive shaft preload. Thus, Steps 1-2-4-5-6 ONLY must be followed.

1. Place original shims in drive shaft housing.
2. Install bearing cup in drive shaft housing with Bearing Cup Driver (C-91-33493). Coat oil seal with Multipurpose Lubricant (C-92-49588).
3. Complete Step 4, following, for checking preload with torque wrench or secure end of a piece of heavy string to center of upper drive shaft and wind it around drive shaft approximately 10 times. End of string should extend about 10" (25cm). (Figure 11)

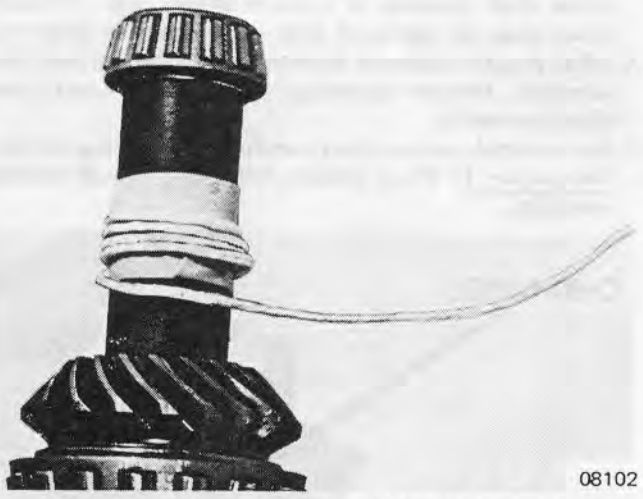


Figure 11. Attaching String to Upper Drive Shaft

4. Coat lower seal lips with Multipurpose Lubricant before placing upper drive shaft assembly in drive shaft housing. Extend end of string thru drive, if Step 3 is followed.
5. Install top cover (or water pump body on 60-80-90 models) without "O" ring.
6. Install and tighten cover (or body) screws evenly while turning drive shaft. Improper over-shimming would be indicated by binding or tightening of drive shaft.

Screw Torque

Models 1-thru-165 and 888: 20 ft. lbs. (2.76mkg)
Models 60-80-90 : 5-8 ft. lbs. (.7-1.1mkg)

7. Complete "A" or "B", following, to determine proper upper drive shaft preload:
   A. Attach an ounce-measuring scale to end of string, as explained in Step 3, preceding. Pull evenly and smoothly on scale. Proper bearing preload will indicate between 32 to 64 ounces of tension (Figure 12) or 2 to 4 in. lbs.

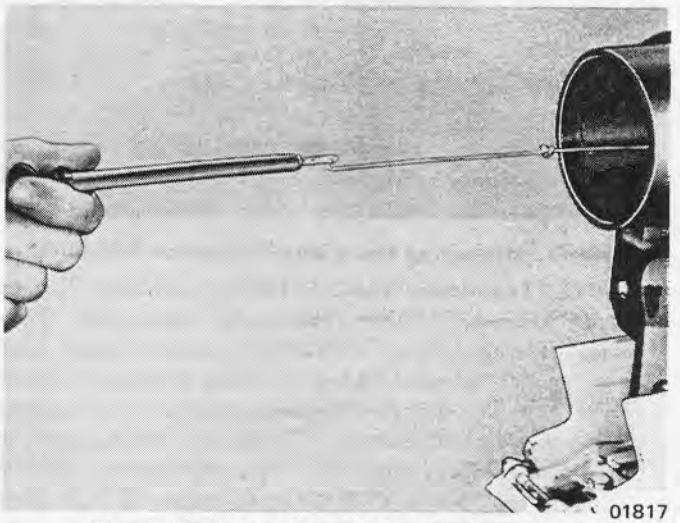


Figure 12. Determining Preload on Drive Shaft

   B. Insert gear housing drive shaft with pinion nut into upper drive shaft splines and use an inch-lbs. reading torque wrench to check preload at 2 to 6 in. lbs. (1.065 to 1.42kg/cm).
8. If more tension is required to turn drive shaft, shims must be removed from under bearing cup in cover or pump base. If tension is less than specified, shims must be added under bearing cup to obtain proper preload.
9. If making a change in shim thickness, cover or pump base again must be torqued before measuring drive shaft bearing preload.

SHIMMING UPPER DRIVE SHAFT GEAR (DRIVEN)

1. Place shimming tool in drive shaft housing thru drive gear opening.
2. Measure clearance between tool surface and flat surface on gear teeth with feeler gauge. (Figures 9 and 10) The 2 outside teeth of the 3 gear teeth, which align with shimming tool, are used to measure clearance. DO NOT measure clearance on center tooth.

NOTE: When using Tool C-91-60526, letter "Z" is used for MerCruiser 888 drive units. Letter "Y" is used for MerCruiser 120-140 drive units and letter "X" for MerCruiser 160-165 drive units.

For correct gear mating, clearance between tool surface and gear tooth must be .025" (.635mm). If gap between tool and gear tooth is greater than specified, shims must be added under bottom bearing cup equal in thickness to amount of feeler gauge reading over specified size. If gap is less than specified, shims equal in thickness to amount of feeler gauge less than specified size must be removed from under bottom bearing cup.

NOTE: On some MerCruiser 120-thru-888 with pressed-on bearing (fine splined) drive shaft, preload is set by Belleville washer in top cover.

IMPORTANT: Any change in shim thickness under bottom bearing cup in drive shaft housing will change drive shaft preload. If shims are removed from under bottom bearing cup, shims equal in thickness must be added under bearing cup in top cover or pump base. If shims are added under bottom bearing cup, shims equal in thickness should be removed under bearing cup in top cover or pump base.

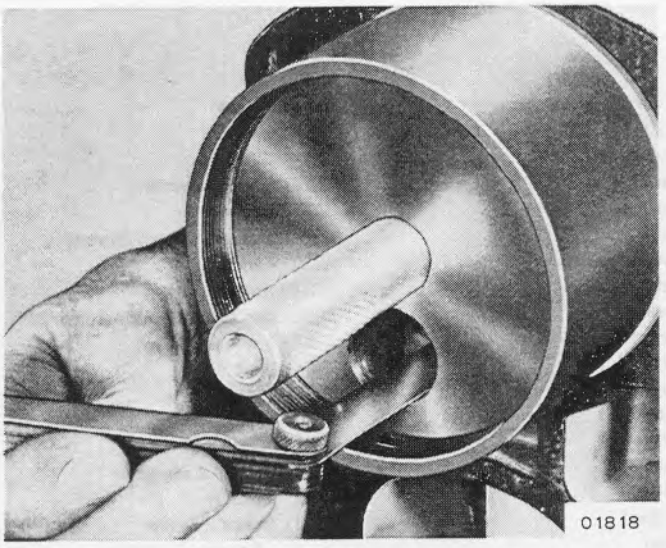


Figure 13. Measuring Gear Clearance - MerCruiser 1-60-80-90

It is suggested that drive shaft bearing preload be rechecked after any changes in shimming which affect amount of gear lash.

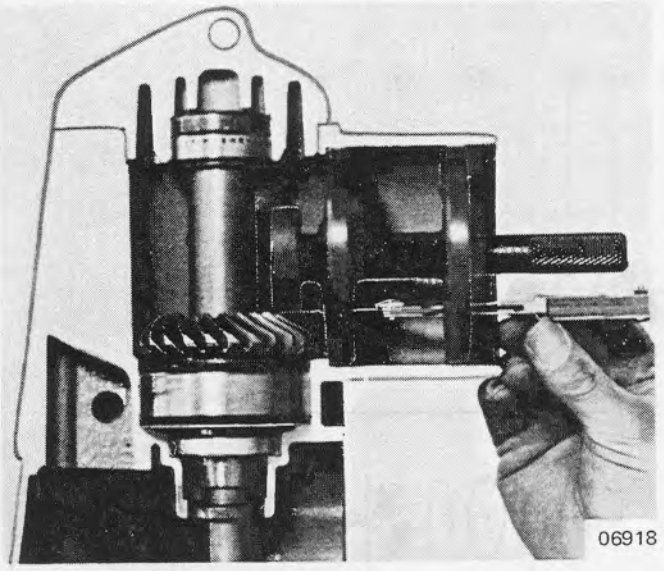


Figure 14. Measuring Gear Clearance - MerCruiser 1A-thru-165 and 888

Shimming Tools (Driven Gear)

MerCruiser 60-80-90 - C-91-38764
MerCruiser I - C-91-33488
MerCr. 1A-1B-1C - C-91-36384
MerCr. 120-140-160-165 - C-91-45878
MerCr. 120-140-165-888 - C-91-60526

MERCRUISER 60-80-90

1. Remove water pump body assembly.
2. Position large "O" ring on water pump base and small "O" rings over ports in drive shaft housing.
3. Install pump body and torque screws to 5-8 ft. lbs. (.7-1.1mkg).

MERCRUISER I-thru-165-888

1. Remove top cover assembly and place "O" ring on cover assembly.
2. Except on MerCruiser IC and 160 drives, reinstall cover assembly in drive shaft housing and torque screws to 20 ft. lbs. (2.76mkg). MerCruiser IC and 160-165 drives require mating gears tooth-for-tooth with the universal joint gear, preceding. (Figure 15)

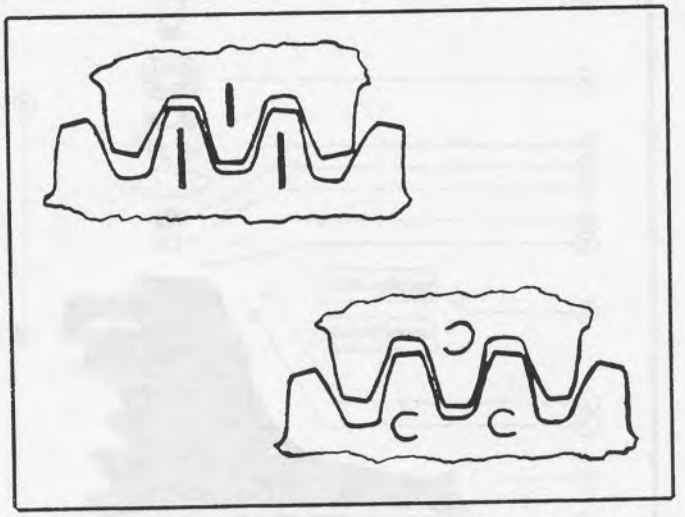


Figure 15. MerCruiser 160-165 Gear (Left) and IC (Right)

NOTE: Perform "Determining Upper Drive Shaft Preload", preceding, for drive shaft without Belleville washer.

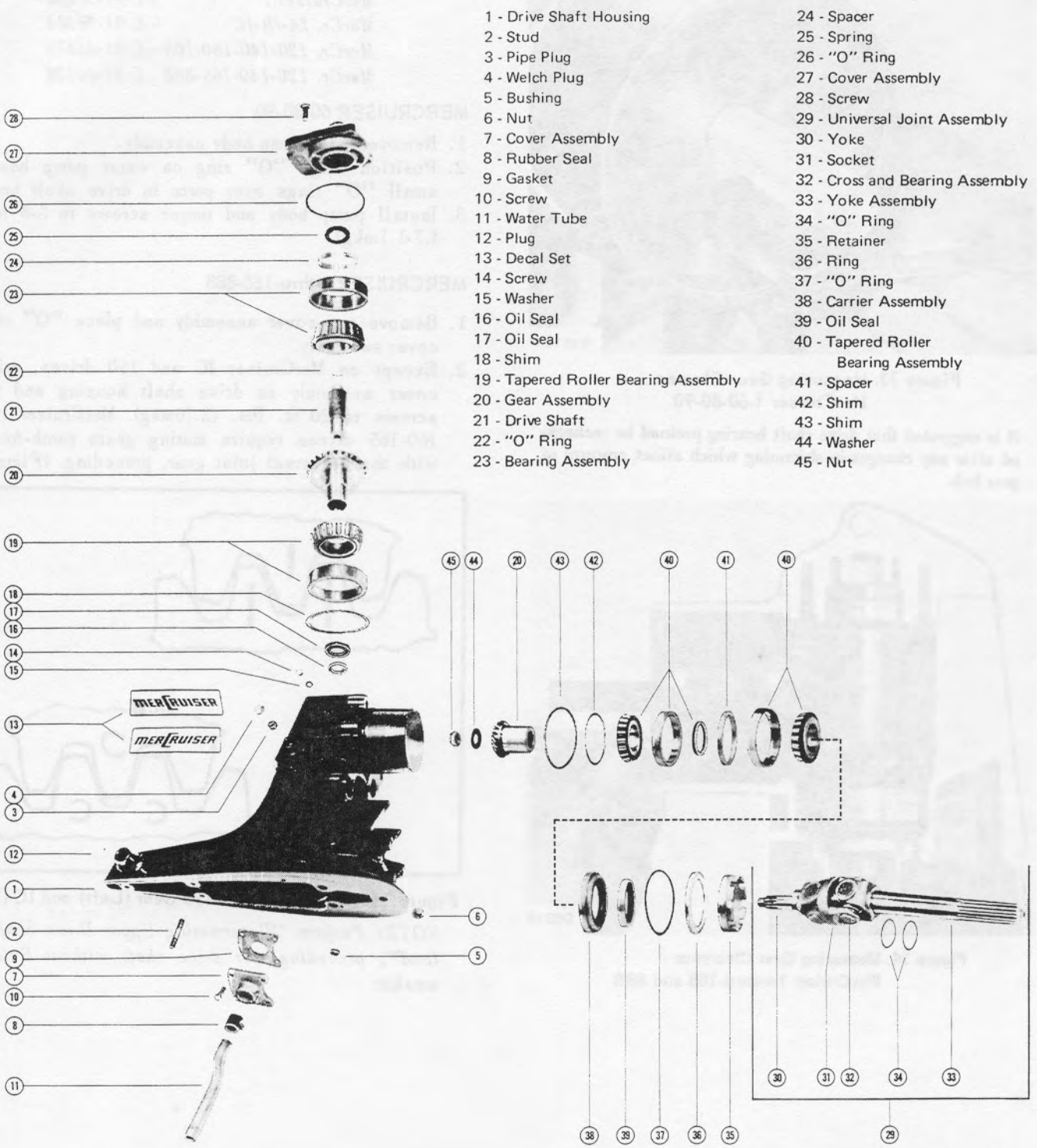


Figure 1. Drive Shaft Housing and Gear Assembly

1 - Bell Housing Assembly
2 - Gasket
3 - Connector
4 - Connector
5 - Drive Screw
6 - Bumper
7 - Bushing
8 - Oil Seal
9 - Bushing
10 - Rubber Gasket
11 - "O" Ring
12 - Washer
13 - Stud
14 - Washer
15 - Nut
16 - Plug Screw
17 - Grease Fitting
18 - Lubricap
19 - Bellows Assembly
20 - Clamp
21 - Water Hose
22 - Clamp
23 - Exhaust Bellows
24 - Clamp
25 - Shift Shaft Assembly
26 - Shift Shaft
27 - Cotter Pin
28 - Washer
29 - Lever Assembly
30 - Washer
31 - Screw

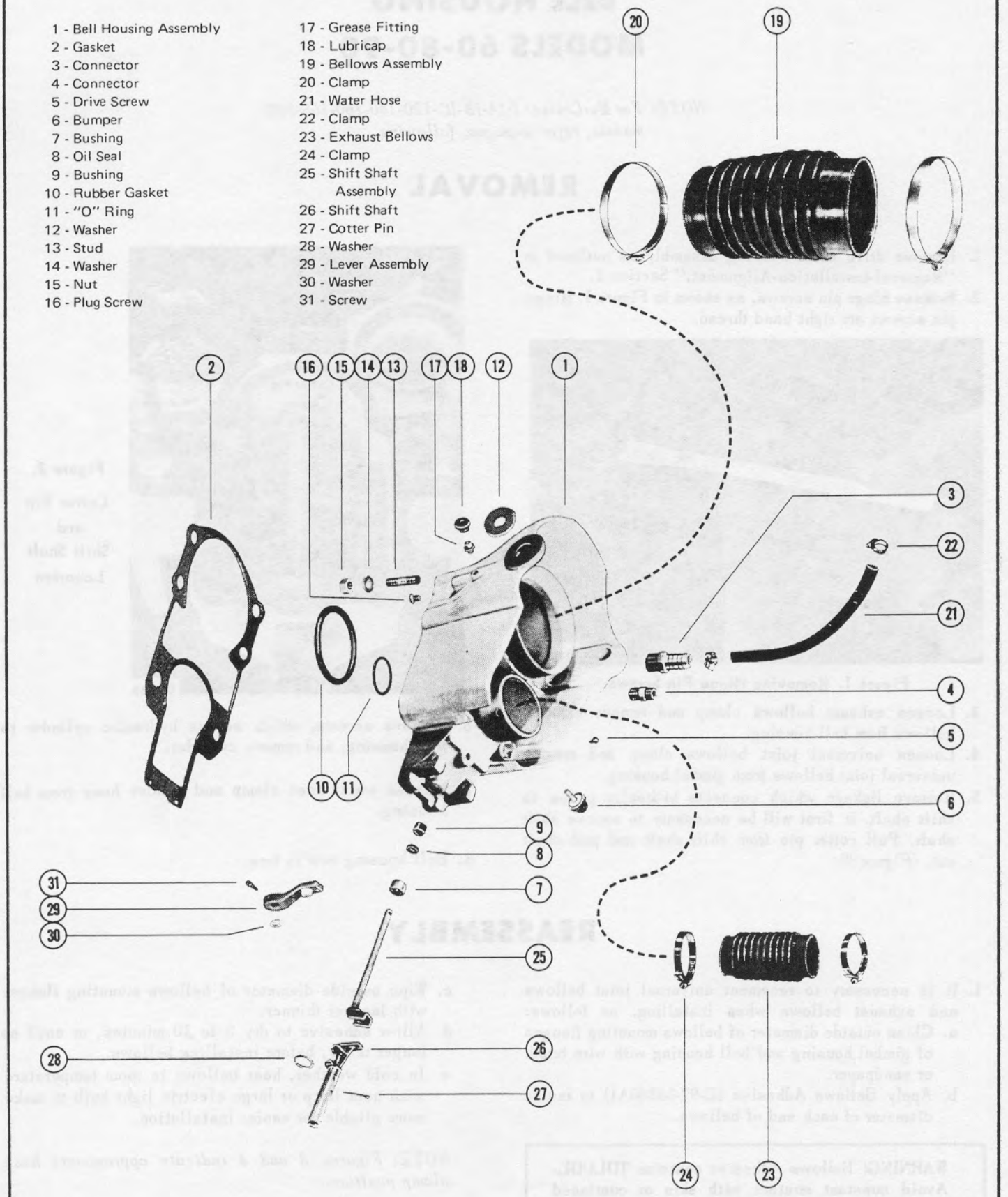


Figure 2. Bell Housing Assembly

BELL HOUSING
MODELS 60-80-90

NOTE: For MerCruiser I-IA-IB-IC-120-140-160-165-888 models, refer to pages, following.

REMOVAL

1. Remove drive shaft housing assembly as outlined in "Removal-Installation-Alignment," Section 2.
2. Remove hinge pin screws, as shown in Figure 1. Hinge pin screws are right hand thread.

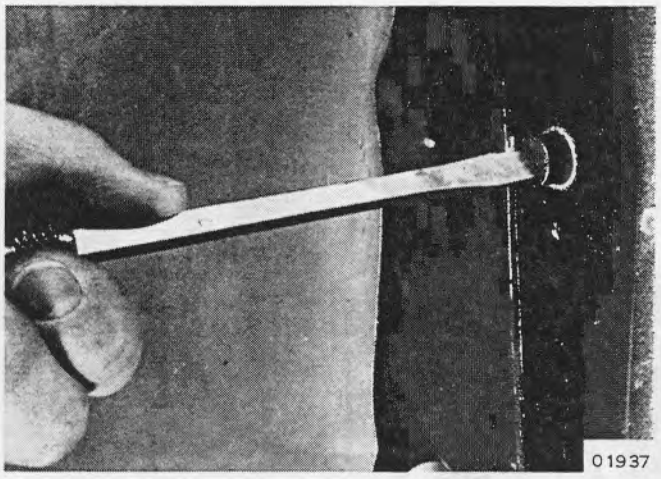


Figure 1. Removing Hinge Pin Screws

3. Loosen exhaust bellows clamp and remove exhaust bellows from bell housing.
4. Loosen universal joint bellows clamp and remove universal joint bellows from gimbal housing.
5. Remove linkage which connects hydraulic piston to shift shaft. It first will be necessary to remove shift shaft. Pull cotter pin from shift shaft and pull shaft out. (Figure 2)

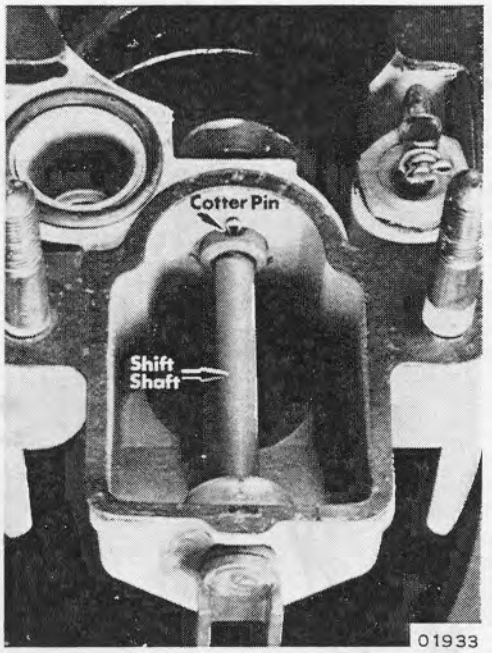


Figure 2. Cotter Pin and Shift Shaft Location

6. Remove screws, which secure hydraulic cylinder to bell housing, and remove cylinder.
7. Loosen water hose clamp and remove hose from bell housing.
8. Bell housing now is free.

REASSEMBLY

1. It is necessary to recement universal joint bellows and exhaust bellows when installing, as follows:
   a. Clean outside diameter of bellows mounting flanges of gimbal housing and bell housing with wire brush or sandpaper.
   b. Apply Bellows Adhesive (C-92-36340A1) to inside diameter of each end of bellows.

WARNING: Bellows Adhesive contains TOLUOL. Avoid constant contact with skin or continued breathing of vapor. Keep away from children. Flammable! DO NOT USE NEAR FIRE OR FLAME!

   c. Wipe outside diameter of bellows mounting flanges with lacquer thinner.
   d. Allow adhesive to dry 5 to 10 minutes, or until no longer tacky, before installing bellows.
   e. In cold weather, heat bellows to room temperature with heat lamp or large electric light bulb to make more pliable for easier installation.

NOTE: Figures 3 and 4 indicate approximate hose clamp position.

   f. Recheck and retighten bellows clamps 3-to-4 hours after replacement.

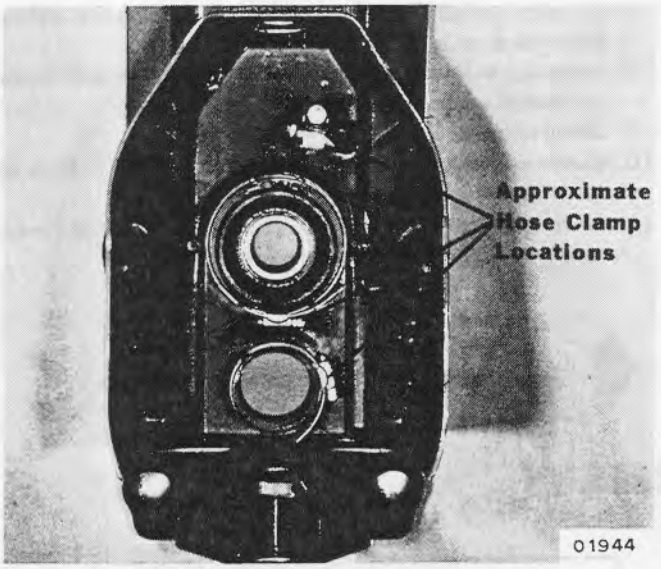


Figure 3. Hose Clamp Locations

2. Install gasket on hydraulic receiver and install receiver on bell housing. Do not tighten screws at this time, since receiver must be tilted to one side to install exhaust bellows.

3. Install exhaust bellows on gimbal housing. Use Gasket Adhesive (C-92-25234) to secure rubber sealing ring to bell housing. Always replace gasket to assure a good seal and to prevent water leakage.

NOTE: MerCruiser 60-80-90 have hole, located in bottom of gimbal housing, to facilitate installing exhaust bellows clamp.

4. Install water hose to gimbal housing and to bell housing.
5. Install universal joint bellows to gimbal housing and to bell housing.

NOTE: Bellows are marked "TOP" to aid correct installation.

6. Install one hinge pin. This will simplify installation of exhaust bellows to bell housing.
7. Install other hinge pin. Place Loctite "A" (C-92-32609) on hinge pin threads and tighten securely.
8. Two screws on hydraulic receiver now can be tightened.
9. Check exhaust and universal joint bellows carefully. They must not be kinked or folded unevenly.
10. Reinstall drive unit as outlined under "Installing Drive Shaft Housing to Bell Housing", preceding in this section.

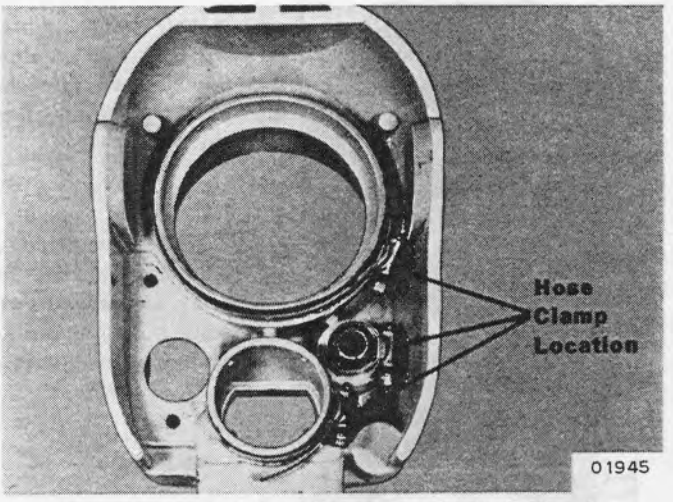


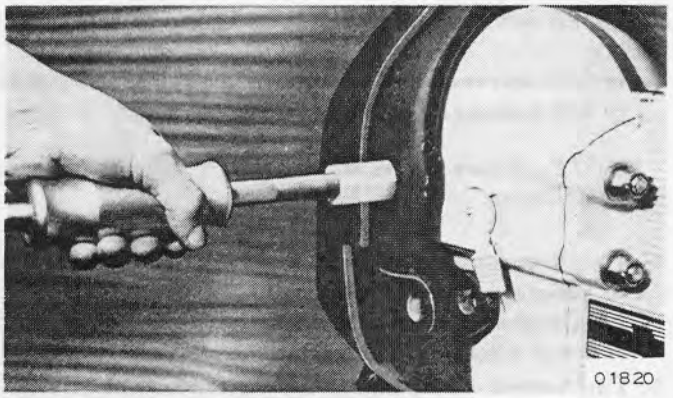
Figure 4. Hose Clamp Locations in Bell Housing

MODELS I-thru-165, 888 and E-Z SHIFT

NOTE: Repair procedures for MerCruiser I-thru-165 and 888 are parallel, except where indicated. Refer to preceding pages for MerCruiser 60-80-90.

REMOVAL

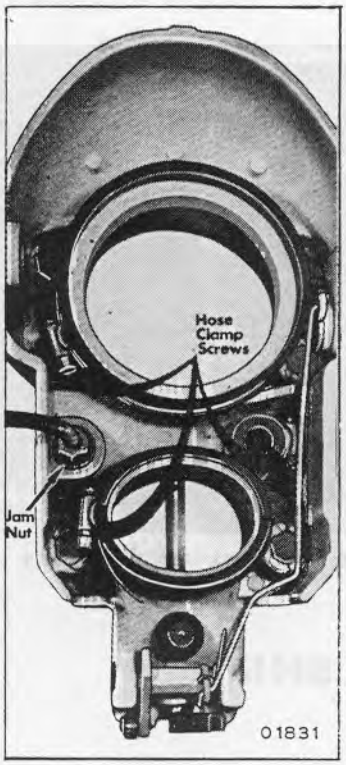
1. Remove drive shaft housing assembly according to preceding instructions.
2. Disconnect shift cable from inner transom plate and remove cable end guide. Remove burrs made by set screws on core wire so that inner lining of cable will not be damaged when wire is removed.
3. Remove inner wire and cable slide.
4. Loosen cable end insert jam nut and back insert out of cable.
5. On some models, remove clamp which secures shift cable to inner transom plate.
6. Remove hinge pin lock screws or pins and remove hinge pins with Hinge Pin Puller (C-91-32327A1) or with Slide Hammer Puller (C-91-34569A1) and Puller Adaptor (C-91-36060), as shown in Figure 5.



7. Loosen exhaust bellows clamp and remove exhaust bellows from bell housing.
8. Loosen universal joint bellows clamp and remove universal joint bellows from bell housing.
9. Remove shift cable bellows crimp clamp.
10. Loosen water hose clamp and remove hose from bell housing.
11. Bell housing now is free. Shift shaft and/or reverse lock lever linkage can be removed.

Figure 5. Removing Hinge Pins

REASSEMBLY



1. Install outer shift cable. Keep cable guide end straight when tightening jam nut. (Figure 6)

NOTE: Replacement cables require that fitfitting be removed bell housing to accept new one-piece cable fitting.

Figure 6.
Outer Shift
Cable Installed

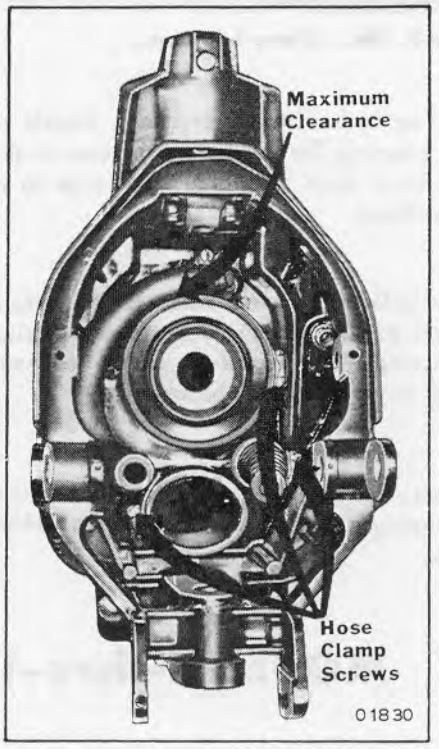


Figure 7.
Hose Clamp
Screws Installed
in Bell Housing

2. It is necessary to recement universal joint bellows and exhaust bellows when installing, as described in procedure, following. When replacing bellows on drive units, recheck and retighten bellows clamps 3-to-4 hours after replacement as a precaution to prevent bellows from loosening.

NOTE: Figures 6 and 7 indicate approximate hose clamp position.

3. Install exhaust bellows on gimbal housing. Later gimbal housings have a hole to facilitate exhaust bellows clamp installation. (Figure 8)

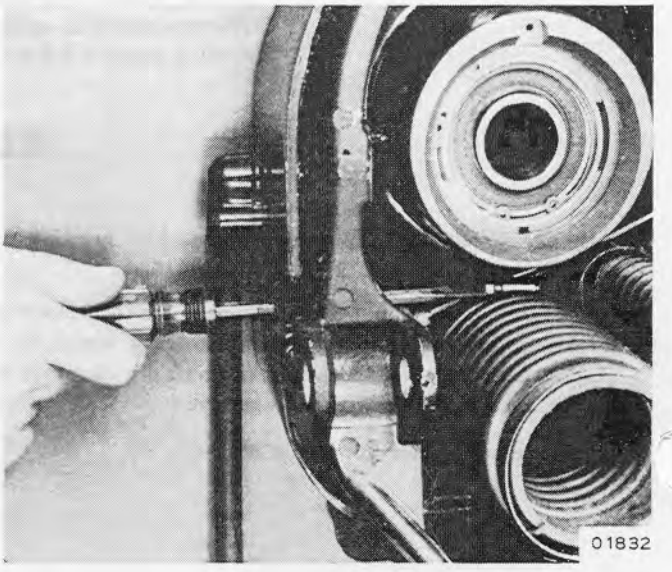


Figure 8. Installing Exhaust Bellows Clamp

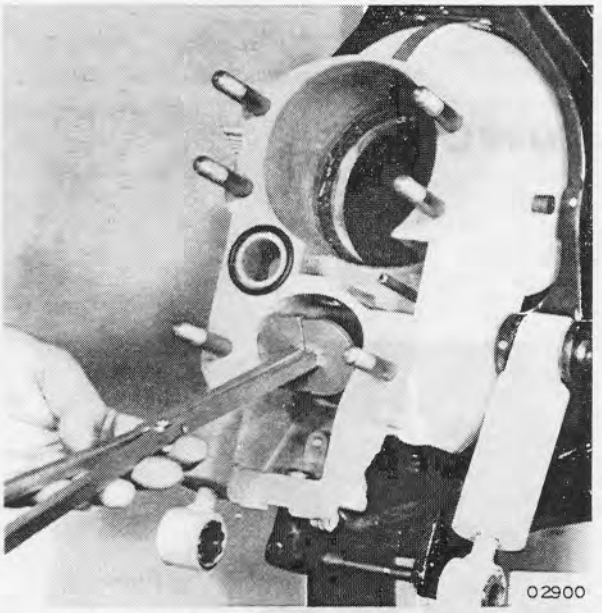


Figure 9. Tool Placed into Bell Housing Exhaust Outlet

4. Install shift cable bellows on gimbal housing.
5. Install water hose on bell housing.
6. Install universal joint bellows on bell housing according to instructions which follow. Late model bellows is marked "TOP" - "FRONT" to aid installation.
7. Install water hose on gimbal housing.
8. Slide outer cable into shift bellows; do not clamp at this time.
9. Install universal joint bellows on gimbal housing as outlined, following.

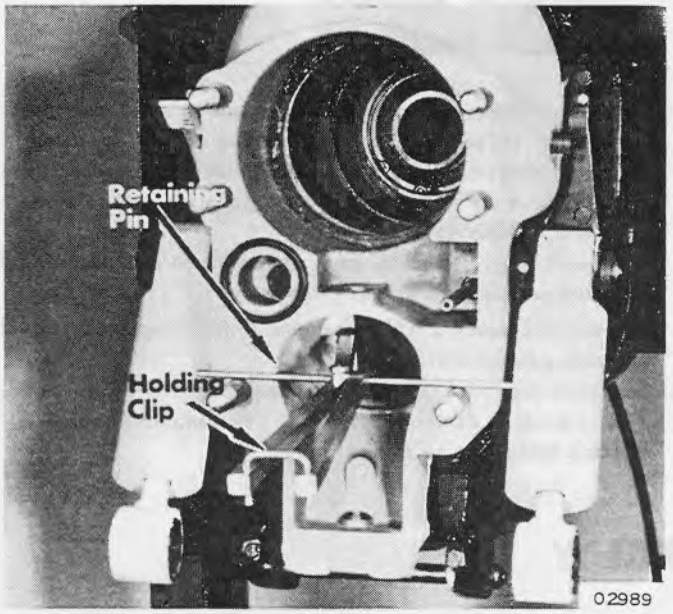


Figure 10. Installing Holding Clip into Tool Handles

10. Install one hinge pin. This will simplify installation of exhaust bellows.
11. Install clamp on shift bellows. End of bellows must be approximately 2" (51mm) from cable connector. Squeeze clamp very securely to prevent water from entering.
12. Install exhaust bellows on bell housing with Expander Tool (C-91-45497A1). (Figures 9 and 10)

    NOTE: Notch tool to clear raised portion of exhaust hole (if necessary).

13. Install other hinge pin. Place Loctite "A" (C-92-32609) on hinge pin lock screws and tighten securely. Later model hinge pins are retained with stainless steel pins.
14. Check exhaust and universal joint bellows carefully for tightness, folds or kinks.
15. Install inner cable and slide.

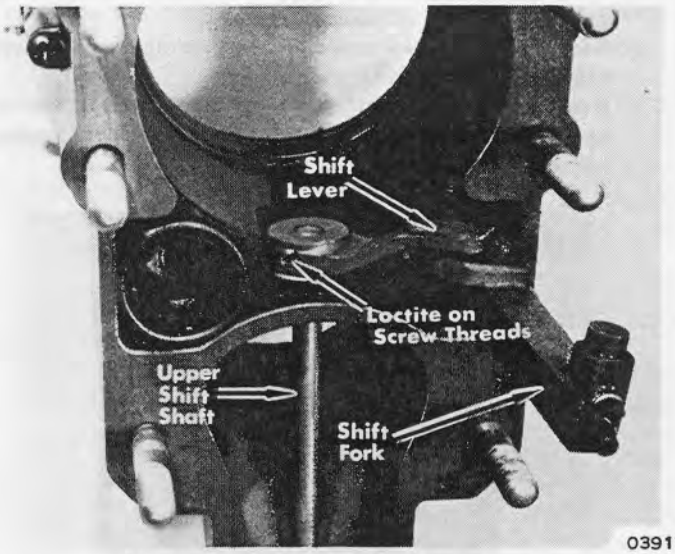


Figure 11. Installing Shift Lever Screw

16. When installing shift cable, the correct tightening procedure for the set screw in the shift actuating cable slide is as follows:
    Tighten screw securely, then back off approximately ¼-turn. The screw must be loose enough to permit cable to turn or rotate freely, but tight enough to minimize end play between cable and cable slide. Secure screw with lockwire.
17. Assemble shift lever and upper shift shaft with proper seals and washers, then retain in place with cotter key on earlier drives or with Loctite "A" (C-92-32609) on threads of locking screw. (Figure 11)
18. Reinstall drive unit, then adjust shift cable; both procedures described in "Installation" Section 2.

GIMBAL RING

MODELS 60-80-90

REMOVAL

It will be necessary to remove engine per instructions in "Removal-Installation-Alignment" Section 2.

1. Remove exhaust bellows and water hose from gimbal housing.
2. Remove 2 screws which secure tilt switch lever to gimbal ring.
3. Remove allen head pipe plug which is located in bottom of upper swivel shaft. (Figure 1)
4. Remove allen head screw, located at upper starboard side of gimbal ring. (Figure 1)
5. Remove screw and nut which secure steering arm to upper swivel shaft. This is located in upper recess of inner transom plate.

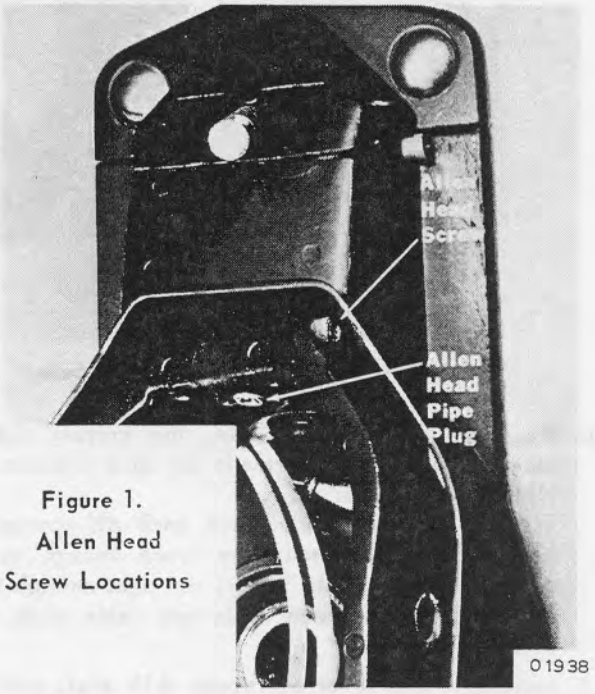


Figure 1.
Allen Head
Screw Locations

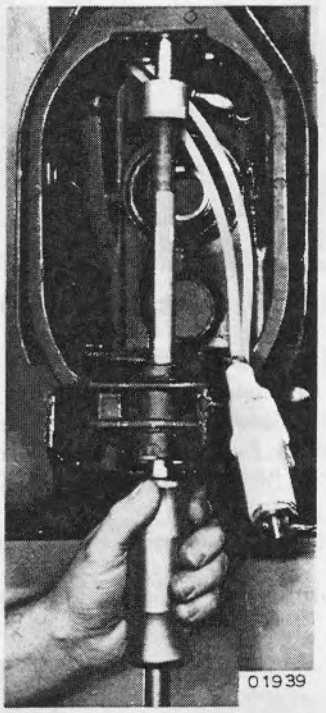


Figure 2.
Removing Upper
Swivel Shaft

6. Remove lower swivel shaft. Remove cotter pin for lower swivel shaft thru hole located in gimbal housing.
7. Swivel shaft can be removed by pulling from bottom with Puller Head (C-91-38919) and Slide Hammer Puller (C-91-34569A1). (Figure 2)
8. Remove switch leads from ignition coil terminal and condenser mounting bracket screw.
9. Remove 2 screws which secure lead retainer plate and bushing to gimbal housing.
10. Gimbal ring and tilt switch assembly can be removed.
11. Tilt switch can be removed by removing 2 screws which secure it to gimbal ring.

REASSEMBLY

1. Install tilt switch, spacer and retaining plate into gimbal ring. Place retaining strap over switch leads and tighten screws and nuts evenly. (Figure 3)
2. Thread switch leads thru gimbal housing.
3. Align gimbal ring and gimbal housing and install lower swivel shaft with stainless steel washer between gimbal ring and upper gimbal housing boss. Install swivel shaft retaining pin.

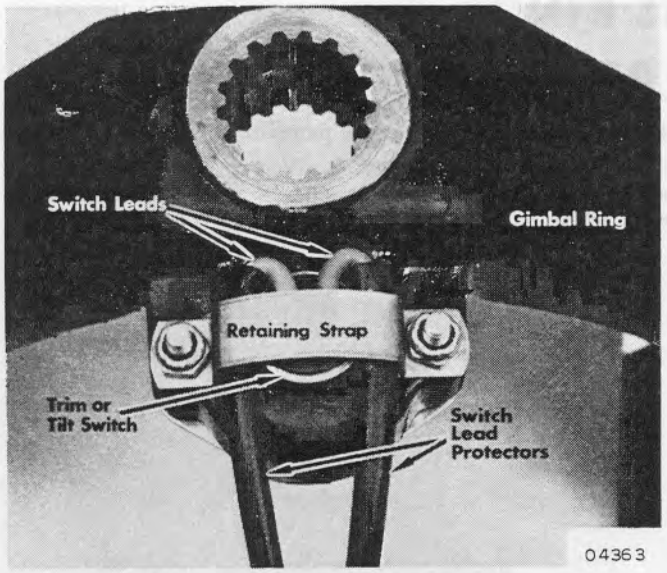


Figure 3. Routing Switch Leads

4. Install upper swivel shaft and steering arm.

   NOTE: Place shim washer(s) under steering arm (Figure 9, following), as required, to maintain an installed clearance of .015" to .030" (.38mm to .76mm) between gimbal ring and gimbal housing at the lower swivel pin.

5. Install steering arm screw and nut and tighten securely.
6. Install allen head screw which is located at upper starboard side of gimbal ring. (Figure 1)
7. Install allen head pipe plug, located in bottom of swivel shaft. (Figure 1)
8. Install switch actuating lever. (Figure 4)
9. Pass tilt switch leads thru retaining cover and protective rubber sleeve.
10. Place one tilt switch lead into each slotted hole in rubber grommet and slide grommet down wires until it stops at temflex sleeve covering wires inside gimbal housing.
11. Feed wires and hydraulic tubing into gimbal housing until grommet seats into tapered hole. Rotate grommet one way or the other (no more than ½ revolution) until both nylon tubes are to front of gimbal housing, in line and up-and-down.
12. Locate grommet retainer cover with large side opening forward and secure with two ¼-28 screws. Proper tubing orientation will have both tubes located in each corner of the large side cover opening.

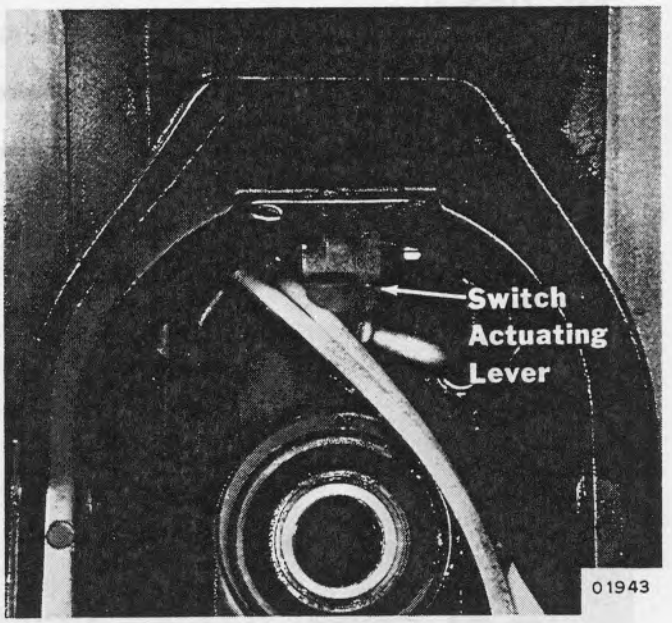


Figure 4. Switch Actuating Lever Installed

GIMBAL RING

MODELS I-thru-165, 888 and E-Z SHIFT

NOTE: Repair procedures for MerCruiser I-thru-165-888 models are parallel, except where indicated. Refer to preceding pages for MerCruiser 60-80-90.

REMOVAL

(See "Alternate Method", following.)

1. Remove exhaust bellows and universal joint bellows and water hose from gimbal housing.
2. Remove 2 screws which secure switch lever to gimbal ring. (Figure 5)
3. Remove allen head pipe plug located in bottom of upper swivel shaft. (Figure 6)
4. Remove allen head screw located at upper starboard side of gimbal ring. (Figure 6)
5. Remove screw and nut which secure steering arm to upper swivel shaft. This is located in upper recess of inner transom plate. Because of limited space, screw can be turned only one notch at a time.
6. Remove pipe plug located in upper recess of gimbal housing.

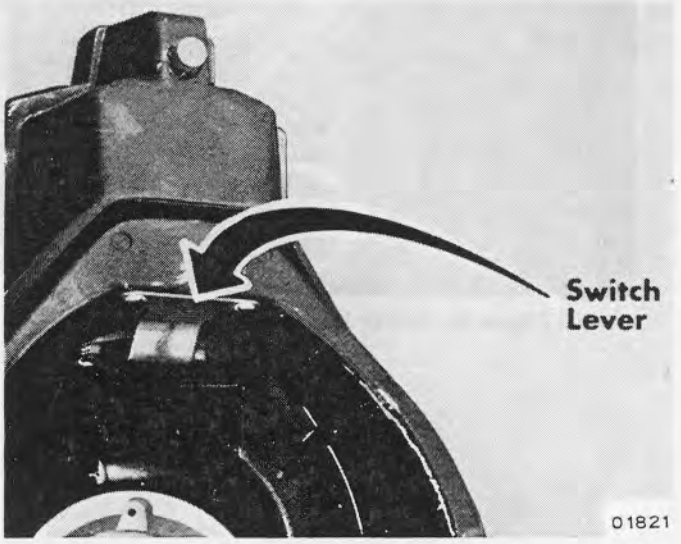


Figure 5. Switch Lever

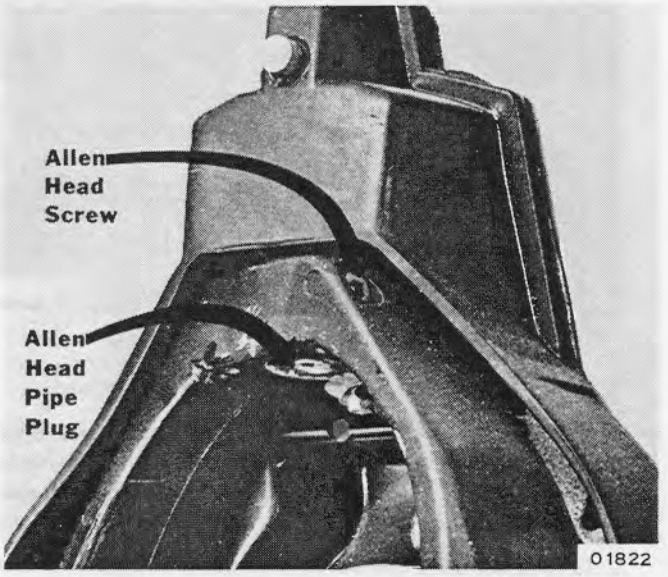


Figure 6. Allen Head Screw Locations

7. Swivel shaft can be removed by using a thin punch thru pipe plug opening or with Puller Head (C-91-38919).
8. Remove retaining roll pin for lower swivel pin with 1/8" punch. Later swivel pins are secured with a cotter pin.
9. Remove lower swivel pin.
10. Remove switch leads from connections on inner transom plate.
11. Remove 2 screws which secure lead retainer plate to gimbal housing.
12. Gimbal ring and switch assembly can be removed.
13. Switch can be removed by removing 2 screws which secure it to gimbal ring. (Figure 7)

ALTERNATE METHOD of REMOVING GIMBAL RING

If boat construction is such that it is difficult or impossible to remove screw that secures steering lever to upper swivel shaft, it is necessary to remove engine and transom plates before attempting to remove gimbal ring or switch. (See "Installation Manual" for removing engine and transom plates.)

NOTE: For replacement of gimbal housing ball bearing, refer to instructions, following.

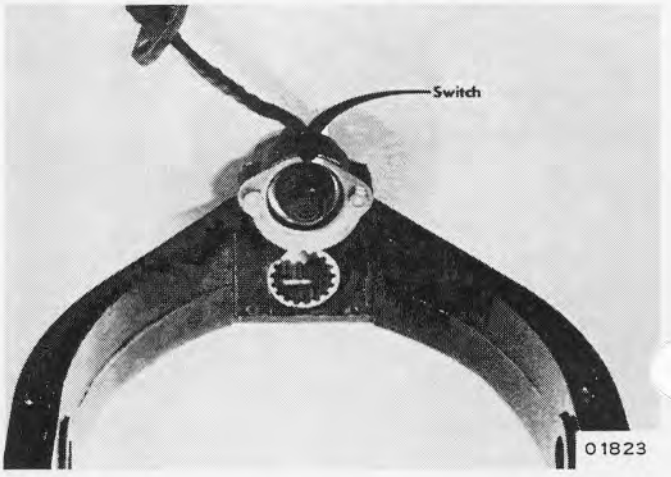


Figure 7. Removing Switch

GIMBAL RING COMPONENT REPLACEMENT

1. Remove needle bearings and oil seals from gimbal ring and gimbal housing, if necessary.
2. Press or drive upper needle bearing in gimbal housing with Needle Bearing Driver (C-91-33489).
3. Press or drive upper oil seal in gimbal housing (lips face up).
4. Press or drive lower oil seal, needle bearing and second lower oil seal in gimbal housing (lips on both oil seals face up). Use Needle Bearing Driver (C-91-33491).
5. Press or drive oil seal, needle bearing and second oil seal in gimbal ring (lips face up on both oil seals). Use Needle Bearing Driver (C-91-33492).

REASSEMBLY

1. Install switch, spacer and retaining plate into gimbal ring. (Figure 7) Place retaining strap on opposite side, route switch leads as shown in Figure 8 and tighten screws and nuts evenly.
2. Thread switch leads thru gimbal housing and install switch lead retainer.
3. Align gimbal ring with gimbal housing and install lower swivel pin with stainless steel washer between gimbal ring and upper gimbal housing boss. Install swivel retaining pin.
4. Install upper swivel shaft and steering arm.

NOTE: Place shim washer(s) under steering arm (Figure 9) as required, to maintain an installed clearance of .015" to .030" (.38mm to .76mm) between gimbal ring and gimbal housing at the lower swivel pin.

5. Install steering arm screw and nut and torque to 50 ft. lbs. (6.9kgm).
6. Install allen head screw which is located at upper starboard side of gimbal ring. (Figure 6)
7. Install allen head pipe plug, which is located in bottom of swivel shaft (Figure 9), and check clearance. (Figure 10) See "NOTE", preceding, under paragraph 4.

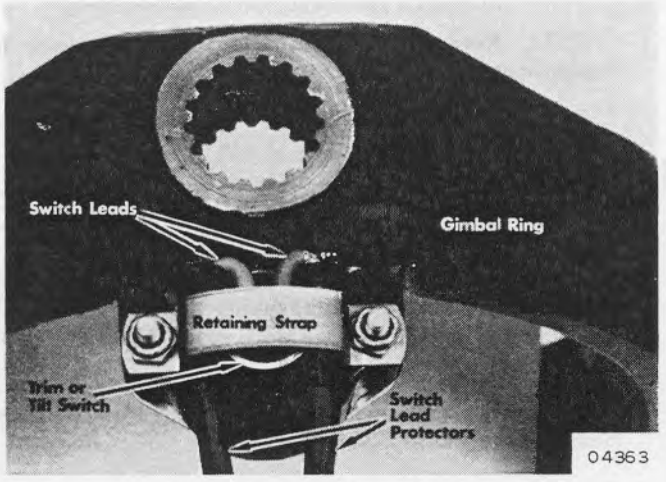


Figure 8. Installing Switch

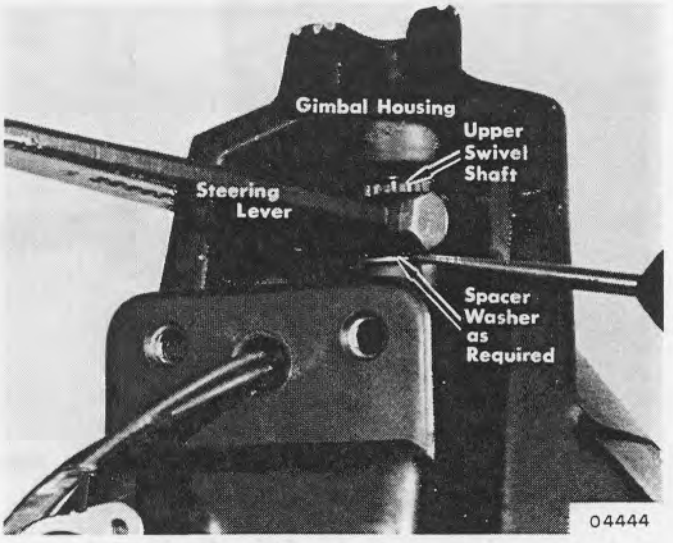


Figure 9. Shim Washer Location

8. Reinstall pipe plug (located in upper recess of gimbal housing).
9. Install switch actuating lever. (Figure 5)

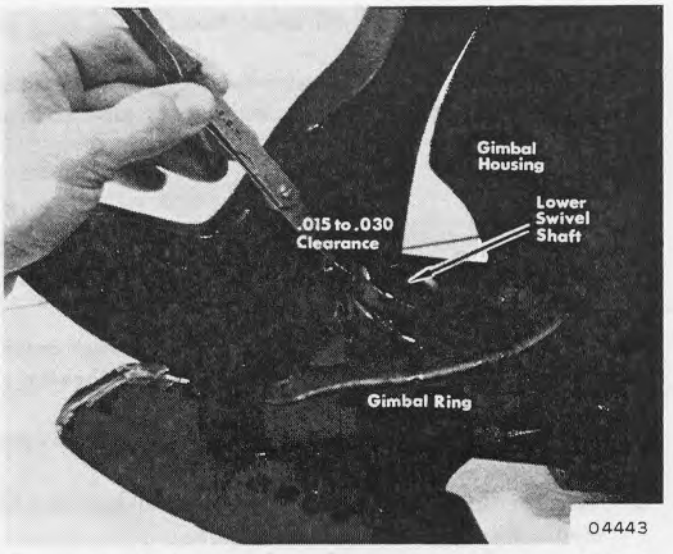


Figure 10. Clearance between Gimbal Housing and Ring

GIMBAL HOUSING BEARING

MODELS 60-80-90

REMOVAL

1. Remove gimbal housing ball bearing with Slide Hammer Puller (C-91-34569A1). (Figure 1)

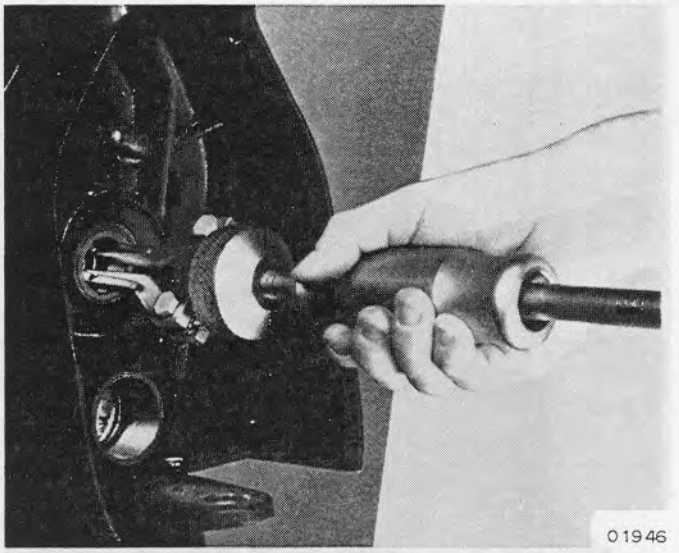


Figure 1. Removing Gimbal Housing Ball Bearing

2. Inspect rubber mount carefully. Replace if worn or damaged.
3. Check ball bearing for roughness.

   NOTE: Ball bearing is a sealed bearing. Do not attempt to clean or lubricate.

4. Remove bushings and oil seals from gimbal ring and gimbal housing.
5. Remove 2 screws from water tube adaptor plate and remove adaptor and bushing. Pull water tube out from opposite side.

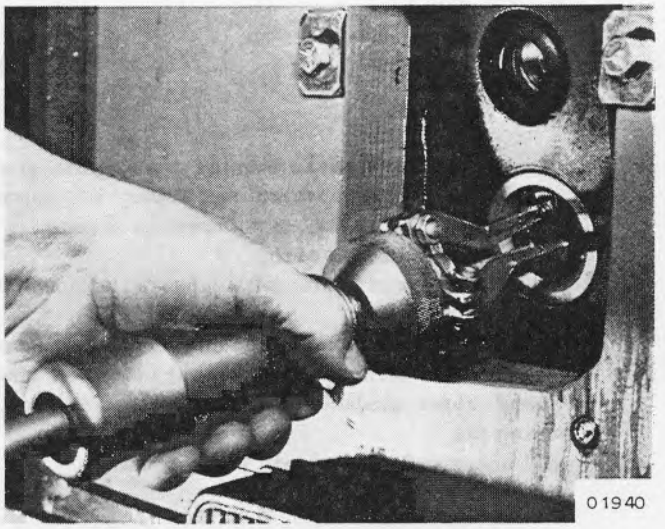


Figure 2. Removing Oil Seal Retainer

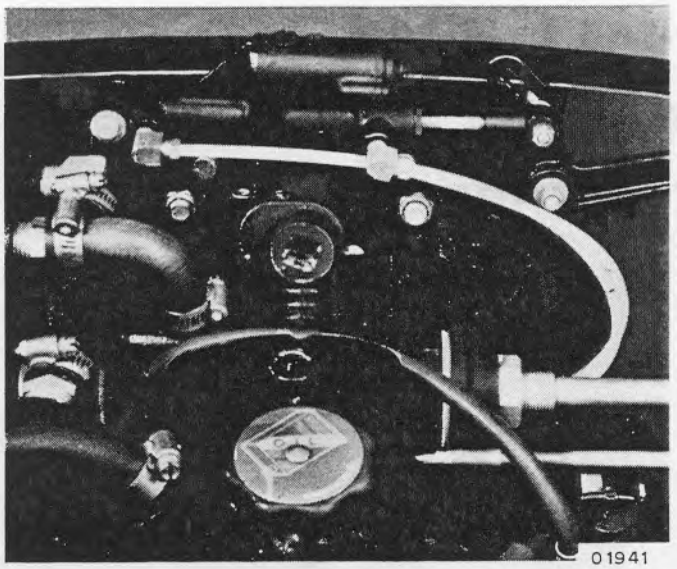
NOTE: Mark inlet and outlet hydraulic lines before removing, to aid in reassembly.

6. Drain hydraulic fluid from sender, receiver and lines. Remove inlet and return hydraulic lines from hydraulic receiver, then remove hydraulic lines from sender.
7. Remove oil seal retainer from exhaust outlet with Slide Hammer Puller (C-91-34569A1) (Figure 2) and remove oil seal.

   NOTE: Refer to "Gimbal Housing Ball Bearing Replacement", preceding.

REASSEMBLY

1. Place ball bearing in rubber mount and cover outside of rubber mount with a coat of Bellows Adhesive (C-92-36340A1).
2. Bearing and mount can be pressed or driven into position.
3. Press or drive upper bushing in gimbal housing with Needle Bearing Driver (C-91-33489).
4. Press or drive upper oil seal in gimbal housing (lips facing up).
5. Press or drive lower oil seal, bushing and second lower oil seal in gimbal housing (lips on both oil seals facing up). Use Needle Bearing Driver (C-91-33491).
6. Press or drive bushings into gimbal ring. Use Needle Bearing Driver (C-91-33492).
7. Press oil seal into exhaust outlet and press oil seal retainer over oil seal.



8. Push hydraulic lines thru gimbal housing and install lines into hydraulic sender. (Figure 3) Fill hydraulic sender according to instructions under "Filling Hydraulic Shift Sender", following.

   NOTE: Leaky or damaged flare on tubing at 90° elbow fitting can be repaired by cutting off the flare evenly and removing the threaded nut. Remove original elbow fitting from sender and install new 90° elbow fitting (B-22-48169). Insert tubing into fitting connector and tighten.

9. Place water tube into gimbal housing and put bushing and adaptor plate on from opposite side. Install 2 screws tightly.
10. Install water inlet hose on water tube and tighten clamp.

Figure 3. Hydraulic Lines Installed

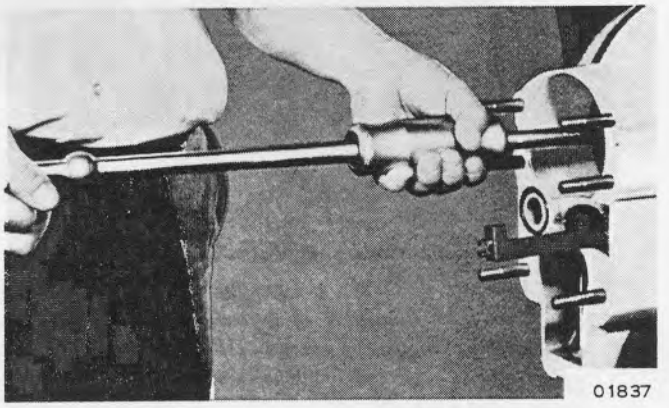
MODEL I

REMOVAL

1. Remove drive shaft housing assembly. (See "Drive Shaft Housing", this section.
2. Remove gimbal housing ball bearing with slide Hammer Puller (C-91-34569A1). (Figure 4)
3 Inspect rubber mount and nylon bushing carefully. Replace if worn or damaged.
4. Check ball bearing for roughness.

   NOTE: Ball bearing is a sealed bearing. Do not attempt to clean or lubricate.

Figure 4. Removing Gimbal Housing Ball Bearing



REASSEMBLY

1. Nylon bushing for ball bearing must be shimmed for correct fit on drive shaft. Try different shims between nylon bushing and ball bearing until bearing fits snugly on drive shaft but is not a drive fit. (Figure 5)

2. Place ball bearing in rubber mount and cover outside of rubber mount with a thin coat of Multipurpose Lubricant (C-92-49588).

3. Bearing and mount can be pressed into position in gimbal housing by hand.

4. Reinstall drive unit as outlined in "Removal-Installation-Alignment", Section 2.

Figure 5. Fitting Bearing on Drive Shaft

MODELS IA-thru-165 and 888

REMOVAL

(Sealed Bearing or Cartridge Bearing)

NOTE: Refer to "Lubrication" Section 1C for lubrication.

1. Remove drive shaft housing assembly.
2. Remove outer snap ring with Ring Pliers (C-91-37240A1). (Figure 6)

NOTE: Snap ring and bearing can be removed without removing bell housing. Housing parts in figures were removed for photography.

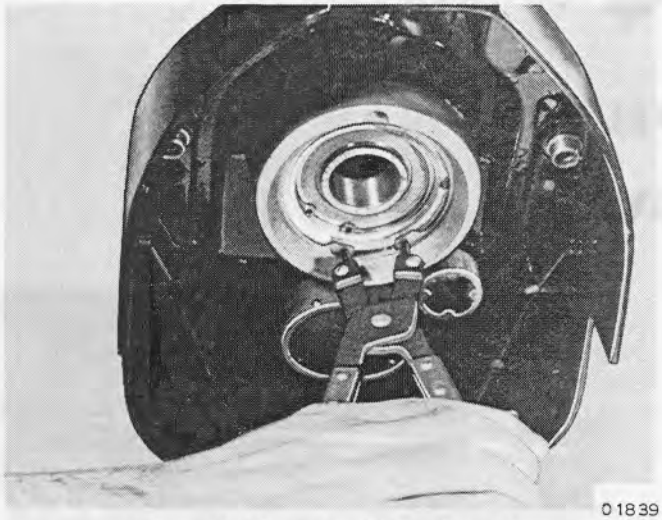


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Figure 6. Removing Outer Snap Ring

NOTE: New type cartridge gimbal bearing assembly can be installed in place of sealed bearing assembly and nylon bushing. (Figures 7-8-9) The cartridge gimbal bearing assembly also may be removed and lubricated periodically.

3. Remove ball bearing and nylon retainer with Slide Hammer Puller (C-91-34569A1). (Figure 4)
4. Check ball bearing for roughness.

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Figure 7. Sealed Ball Bearing Early Type "A"

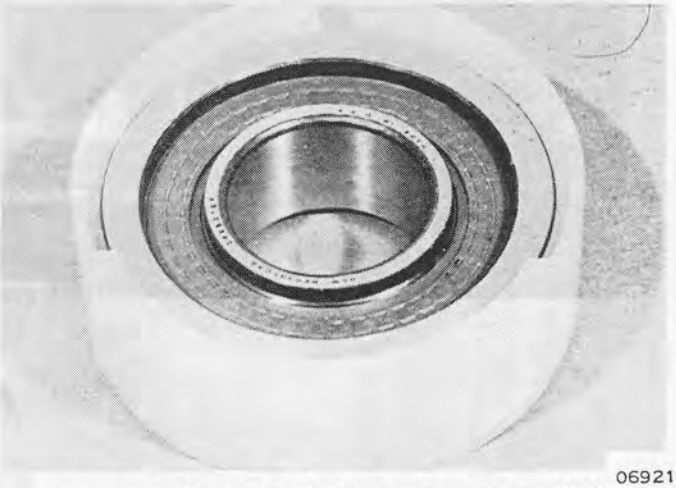

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Figure 8. Sealed Ball Bearing Late Type "B"

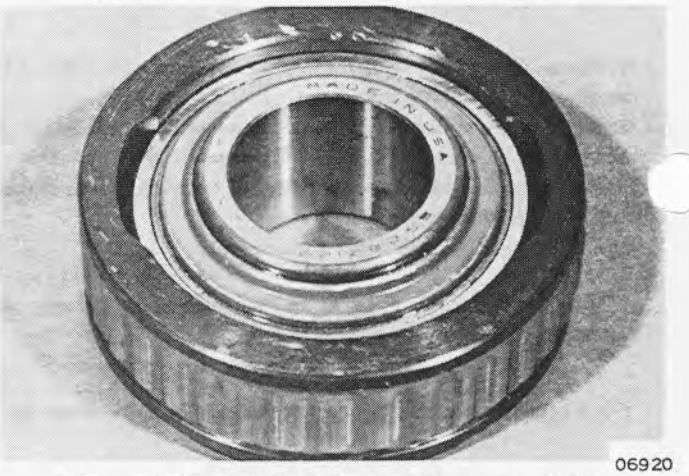

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Figure 9. Sealed Ball Bearing New Type "C"

5. Oil seal can be inspected without removing from gimbal housing. (Figure 10) Replace seal if torn or damaged.

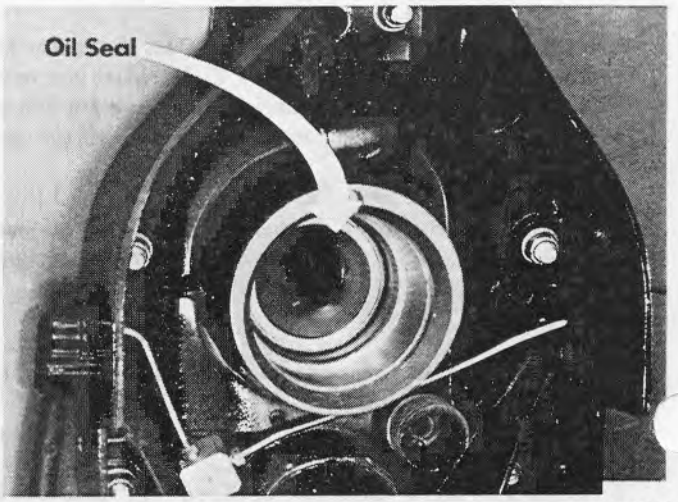

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Figure 10. Inspection Oil Seal

REASSEMBLY
(Sealed Bearing)

NOTE: Ball bearing is sealed. Do not attempt to clean or lubricate. (Figure 7)

1. Late style ball bearing is a one-piece unit and does not require bearing carrier nor snap ring.
2. Install nylon bearing carrier adaptor. Shims must be placed between nylon bearing carrier adaptor and gimbal housing recess so that ball bearing or bearing carrier fits very tightly in nylon adaptor. Try different size shims until ball bearing of bearing carrier just can be tilted into position but is a force fit. Bearing may be tapped in with a wooden dowel. (Figure 11)
3. After installing bearing adaptor, reinstall outer snap ring. (Figure 6)
4. Reinstall drive unit as outlined in "Installation", Section 2.

NOTE: Use Engine Alignment Shaft (C-91-48247) to align gimbal bearing after installation and check engine alignment.

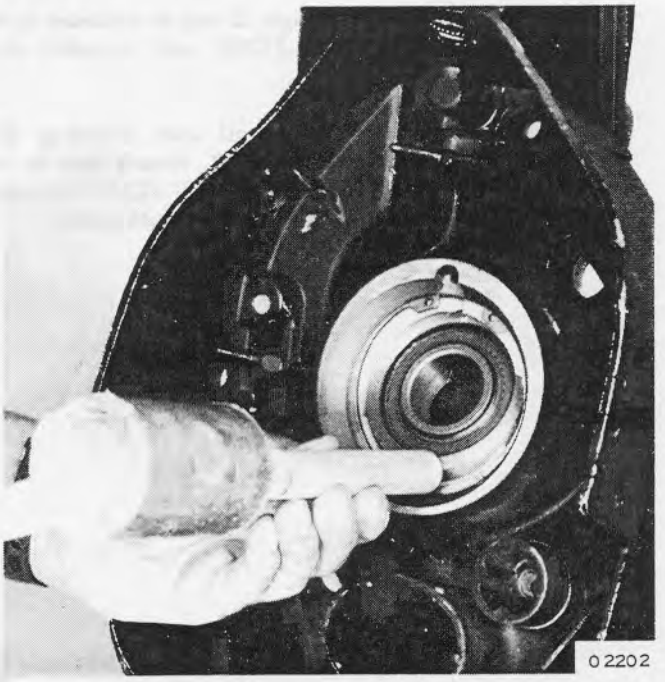


Figure 11. Installing Ball Bearing and Nylon Retainer

REMOVAL
(Bearing Cartridge Assembly)

For INSPECTION and LUBRICATION

NOTE: Gimbal bearing is lubricated through grease fitting (located on right side of gimbal housing). If gimbal housing does not have grease fitting, then bearing must be removed to lubricate as follows.

1. Remove drive unit from bell housing as outlined in "Removal", Section 2.
2. Twist bearing and align with slots in cartridge.
3. Pull bearing from cartridge.
4. Use a suitable tapered grease fitting end on lubricant gun, fill cartridge bearing with (ONLY) Quicksilver Multipurpose Lubricant (C-92-49588).
5. Realign bearing with cartridge slots and install bearing.

NOTE: Use Engine Alignment Shaft (C-91-48247 or C-91-57797A3) to align gimbal bearing after installation and check engine alignment.

6. Install drive unit as outlined in "Installation", Section 2.

For REPLACING CARTRIDGE ASSEMBLY

CAUTION: Gimbal bearing may be damaged during removal. Do not remove bearing cartridge assembly unless replacement is necessary. To remove bearing for inspection or lubrication, refer to "Bearing Removal - For Inspection and Lubrication", preceding.

NOTE: Replacement bearings come as an assembly with cartridge and must be replaced as an assembly.

1. Remove drive unit from bell housing as outlined in "Removal", Section 2.
2. Remove snap ring with Ring Pliers (C-91-37240A1). (Figure 12)

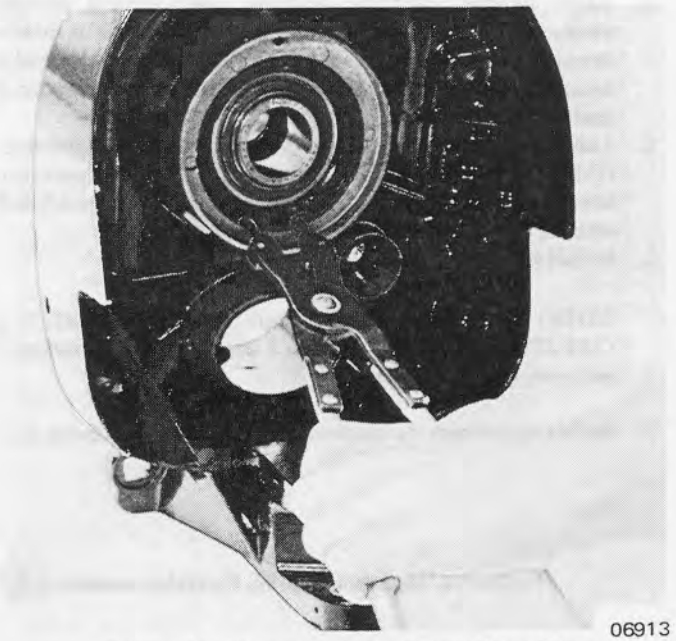


Figure 12. Removing and Installing Snap Ring

3. Remove bearing cartridge assembly with tools illustrated in Figure 13. Two (2) plates (C-91-29310) must be used. Position plates between top and middle studs (located on bell housing). Use 3-jaw puller from Slide Hammer Puller (C-91-34569A1).
   If bearing assembly is very tight, it may be necessary to tap end of Puller Shaft (C-91-31229) with a mallet while turning nut (C-11-24156).

   NOTE: Older Bearing Removal and Installing Kits (C-91-31229A4) will need 5/8-18 threads cut in unthreaded portion of Puller Shaft (C-91-31229) to accept slide hammer 3-jaw puller and jaw spreader adaptor.

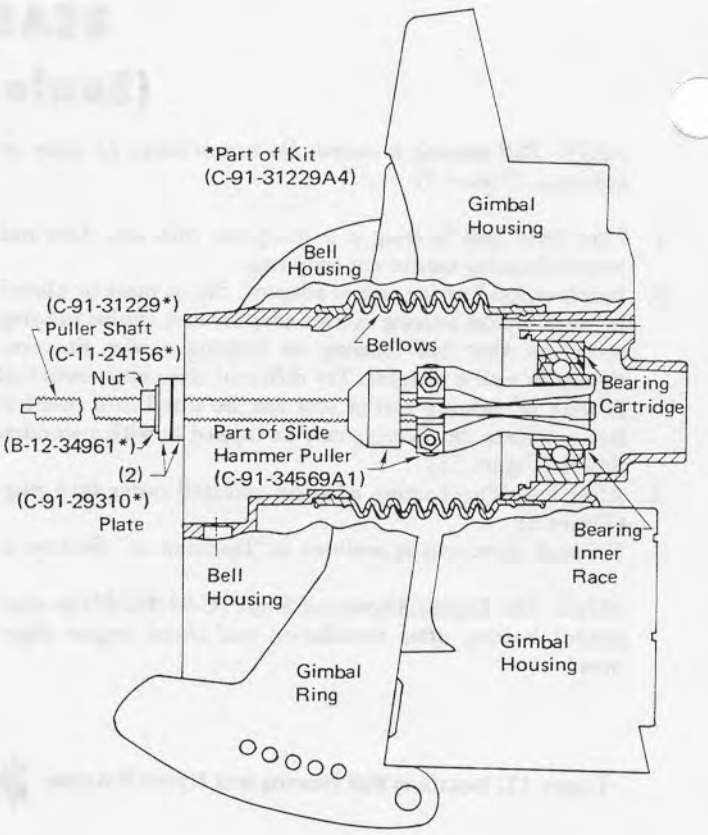


Figure 13. Removing Bearing Cartridge Assembly

INSTALLATION

1. Lubricate outside of cartridge gimbal bearing assembly with Quicksilver Multipurpose Lubricant (C-92-49588).
2. Install bearing cartridge assembly with tools illustrated in Figure 14.
3. Insert Driver Head (C-91-32325) thru Mandrel (C-91-30366) and into inside diameter of bearing assembly.
4. Align bearing cartridge assembly with gimbal housing cavity. Place Plate (C-91-29310) between top and middle studs (on bell housing) as a pilot. Drive bearing cartridge assembly into gimbal housing cavity with a lead hammer or mallet.
5. Lubricate cartridge gimbal bearing with Pistoluber (C-91-37299), using ONLY Quicksilver Multipurpose Lubricant (C-92-49588) thru grease fitting. Pump 40 full strokes (1 oz.) to adequately lubricate bearing.
6. Install snap ring. (Figure 12)

   NOTE: Use Engine Alignment Shaft (C-91-48247 or C-91-57797A3) to align gimbal bearing after installation and check engine alignment.

7. Install drive unit as outlined in "Installation", Section 2.

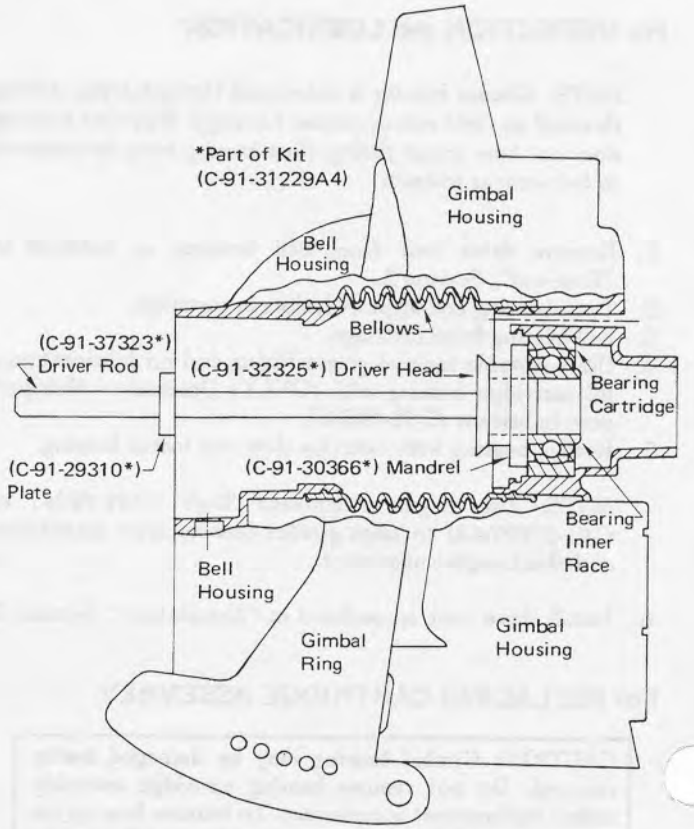


Figure 14. Installing Bearing Cartridge Assembly

DRIVE SHAFT HOUSING and BELL HOUSING VARIATIONS

NOTE: When replacing bell housing and/or bell housing to drive shaft housing gaskets, it is mandatory that bell housing and gaskets match drive shaft housing so that a good seal will be made between the 2 parts.

DRIVE SHAFT HOUSING to BELL HOUSING COMBINATIONS

1. Drive shaft housing with the thin flange may be used with short screws, hardened washers and bell housing with internal nuts (Figure 1) or with bell housing with short studs (Figure 2).

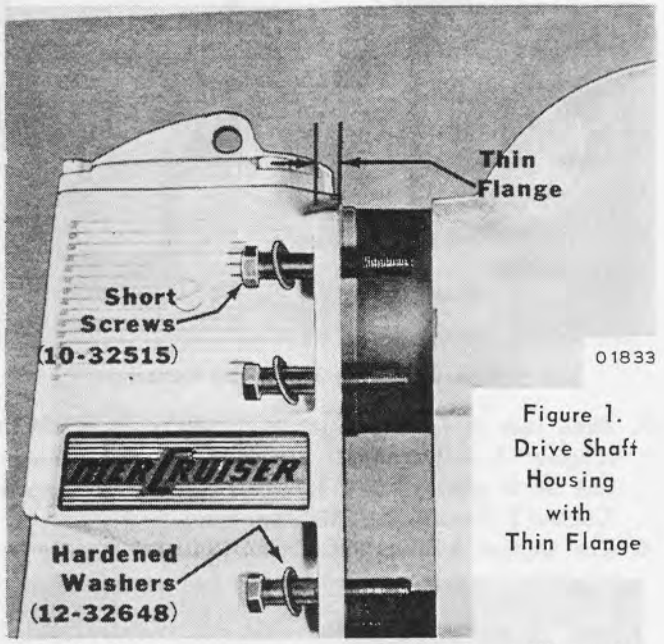


Figure 1. Drive Shaft Housing with Thin Flange

NOTE: Service replacement bell housing will not incorporate the reverse hook release lever. Release drive by pushing down on reverse hook assembly. The replacement bell housing will have studs to be installed in place of screws.

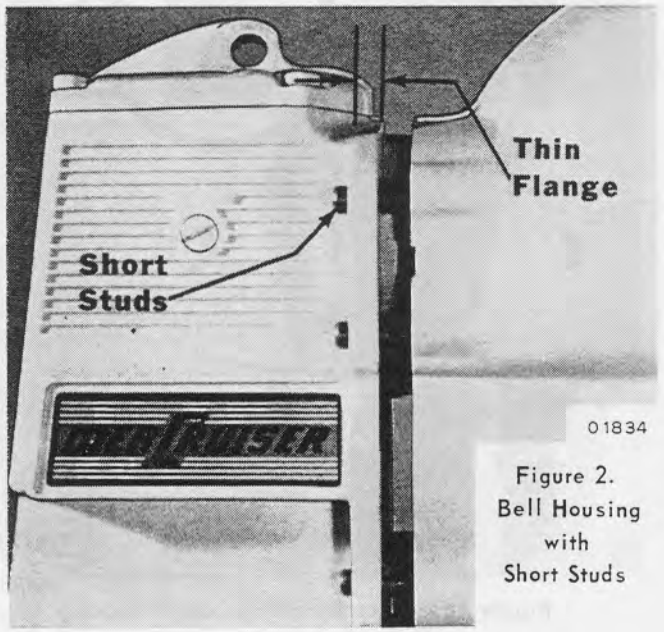


Figure 2. Bell Housing with Short Studs

2. Drive shaft housing with thick flange may be used with long screws, hardened washers and bell housing with internal nuts. (Figure 3) or with bell housing with long studs (Figure 4).

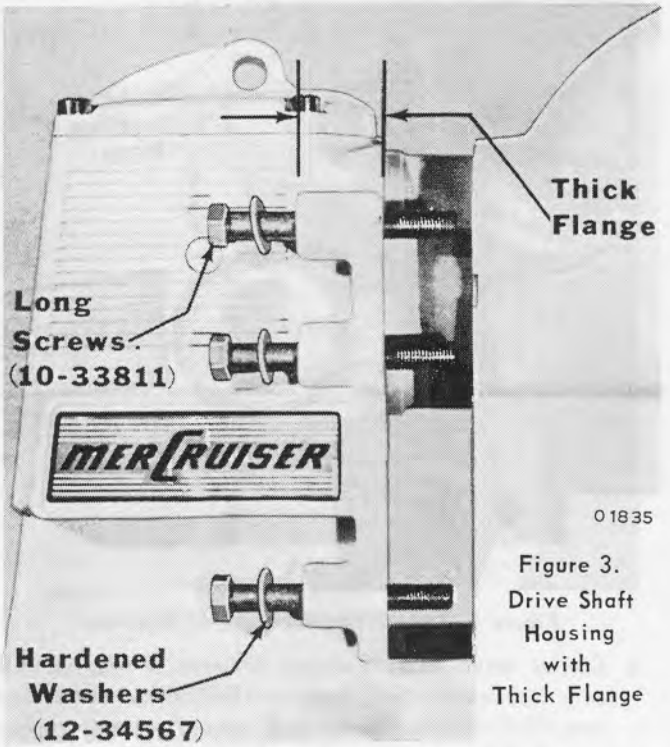


Figure 3. Drive Shaft Housing with Thick Flange

NOTE: Refer to "Replacing Bell Housing in Gimbal Ring", preceding, for additional information.

3. Power Trim drive shaft housing will not have reverse lock mechanism incorporated.

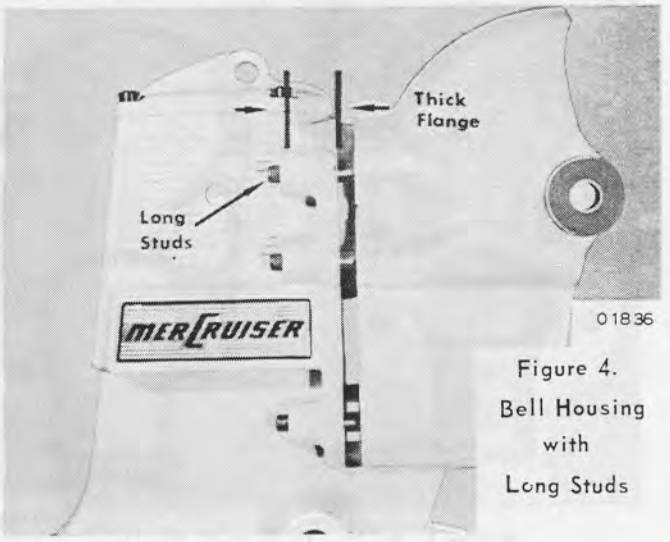


Figure 4. Bell Housing with Long Studs

MERCRUISER I DRIVE SHAFT HOUSING to BELL HOUSING GASKET COMBINATIONS

1. Late style drive shaft housing (Figure 5) can be used with either the earlier bell housing (Figure 6) or late bell housing (Figure 7), providing that the correct gaskets are used. Gaskets for earlier bell housing (2 gaskets B-27-32599) are shown in Figure 6, for late bell housing (one gasket B-27-33796) in Figure 7.

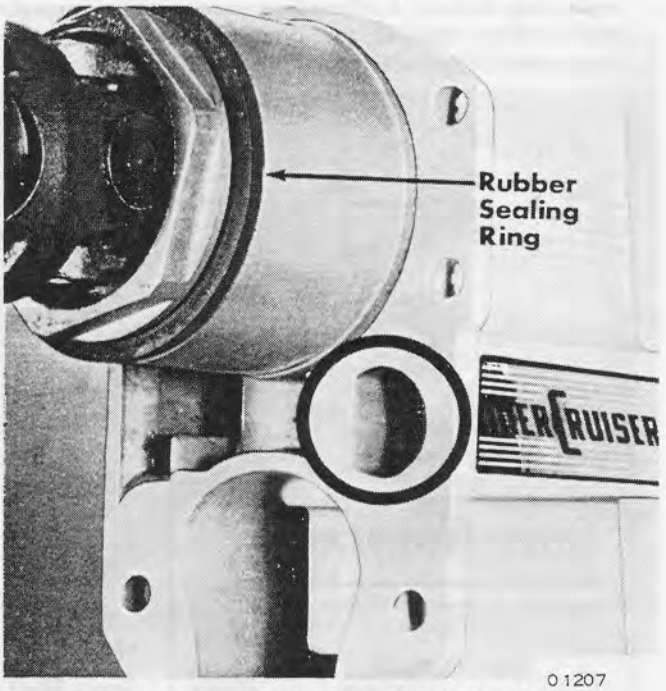


Figure 5. Late Style Drive Shaft Housing

2. Earlier drive shaft housing (Figure 8) can be used only with earlier bell housing (B-32499A1) and 2 gaskets (B-27-32599), shown in Figure 6, or with replacement bell housing assembly (B-34140A1) used on MerCruiser I (Serial No. 1535211 and below).

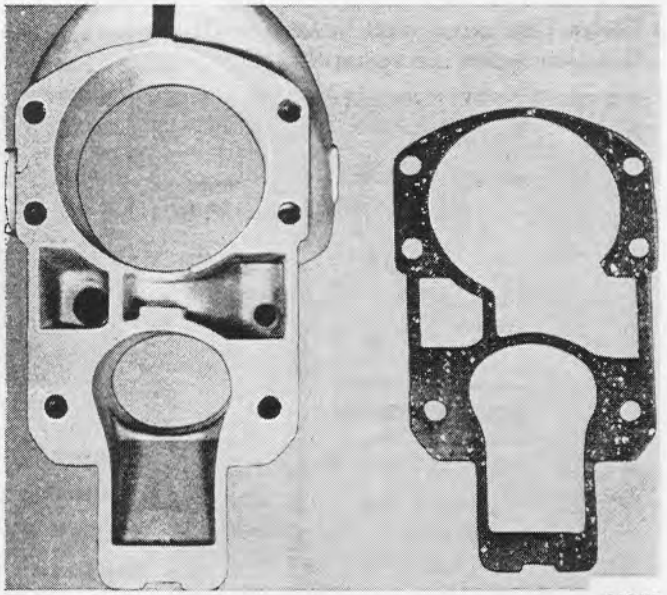


Figure 6. Earlier Style Bell Housing

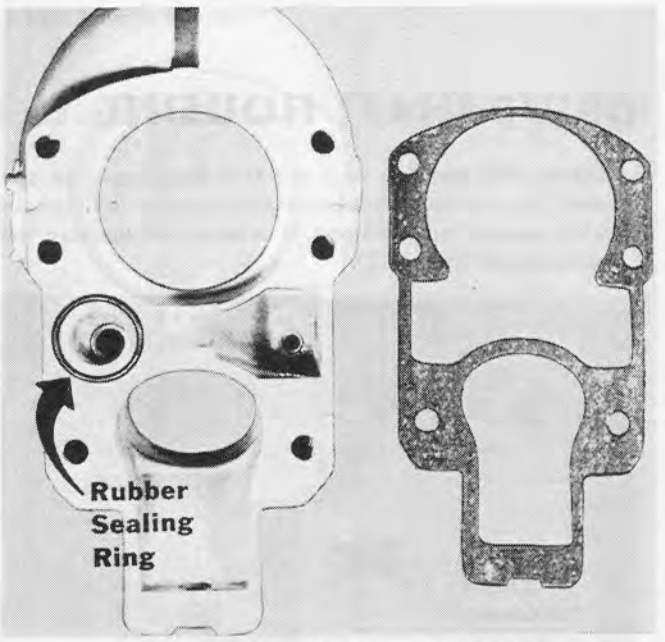


Figure 7. Late Style Bell Housing

3. When late style bell housings B-33506A1, B-33795A3 (Figure 7) or B-52384A1 are used, be certain to use late style gasket (B-27-33507 or B-27-33796) on MerCruiser I (Serial No. 1535212 and up).
4. Use Gasket Adhesive (C-92-25234) to secure gaskets.

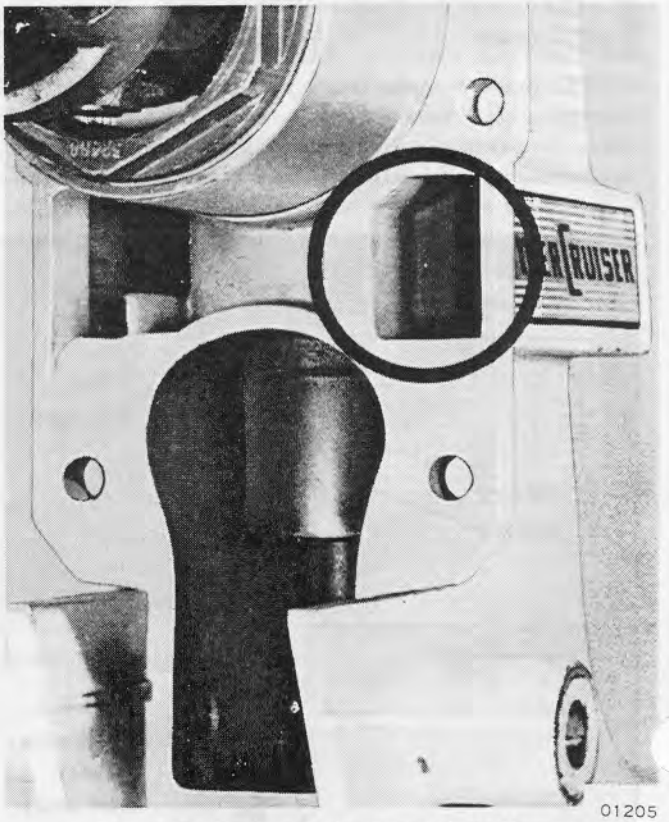


Figure 8. Earlier Style Drive Shaft Housing

MERCRUISER IA-thru-165 and 888 DRIVE SHAFT HOUSING to BELL HOUSING GASKETS

NOTE: Do not attempt to install a MerCruiser I drive shaft housing on a MerCruiser IA-IB-IC bell housing. Although the bolt pattern is the same, the drive shaft will not align with the gimbal housing ball bearing.

1. Use Gasket Adhesive (C-92-25234) to secure rubber sealing rings to bell housing.
2. Use gasket B-27-35996 for IA-IB-IC and E-Z Shift models or use gasket B-27-45821 for 120-140-160-165-888 models. Always replace gasket to assure a good seal and to prevent water leakage.

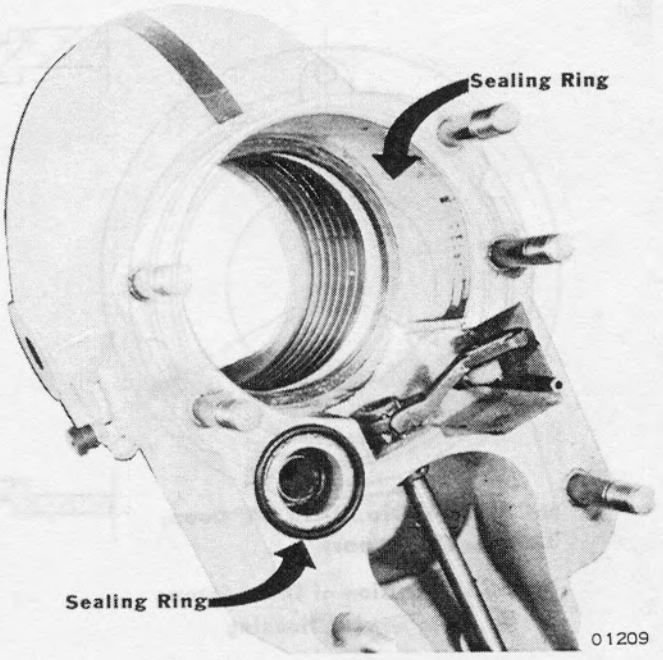


Figure 9. Sealing Rings on Bell Housing

UNIVERSAL JOINT BELLOWS INSTALLATION

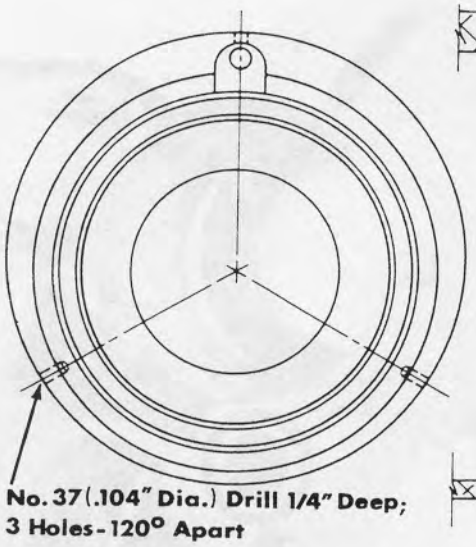


Figure 1. Position of Drive Screws in Gimbal Housing

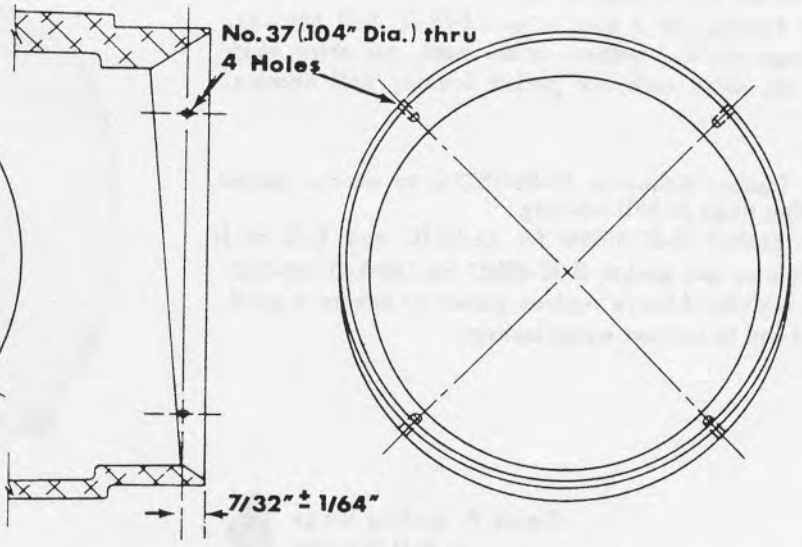


Figure 2. Position of Drive Screws in Bell Housing

When repairing MerCruiser IA-IB-IC stern drive units, install drive screws in universal joint bellows flange on both bell housing and gimbal housing. Installation of the drive screws provide a more positive means of fastening the bellows to the flanges. Later production drive units will have the drive screws already installed.

To install drive screws:

1. Position screws in flanges in approximate locations shown in Figures 1 and 2.
2. Drill holes by placing a right angle drill adaptor on a drill.

It will be necessary to cement universal joint bellows when reinstalling, as follows:

1. Clean outside diameter of bellows mounting flanges of gimbal housing and bell housing with wire brush or sandpaper.
2. Apply a thin coating of Bellows Adhesive (C-92-36340A1) to inside diameter of each end of bellows.

NOTE: Universal joint bellows now are marked "Forward Top" toward transom and "Aft Top" toward bell housing for proper installation. (Figure 3)

When spring is installed in bellows, there must be at least one convolution without spring in "Forward Top" end which has a flat on each side.

Bellows must have inside surface, which is placed over flange, roughened to assure better adhesion. If, for any reason, this has not been done, roughen the inside with sandpaper.

3. Wipe outside diameter of bellows mounting flanges with lacquer thinner.

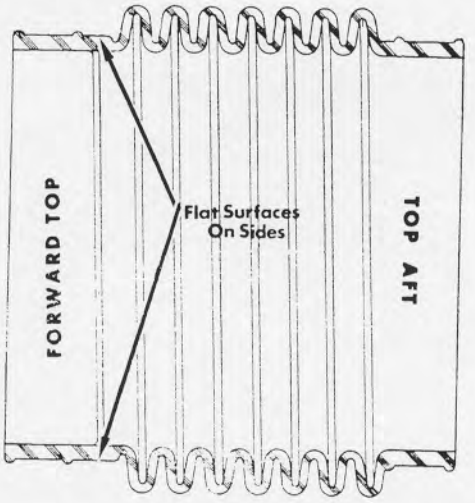


Figure 3. Bellow's Markings

4. Allow adhesive to dry 5 to 10 minutes, or until no longer tacky, before installing bellows.
5. In cold weather, heat bellows to room temperature with heat lamp or large electric light bulb to make more pliable for easier installation.
6. Place hose clamps around bellows and flanges and tighten securely.
7. Position clamps beyond heads of drive screws. This will prevent clamps and bellows from slipping off.

EXHAUST TUBE REPLACEMENT

MerCruiser I-thru-IC E-Z Shift Gimbal Housings

NOTE: Inspect the exhaust tube (B-32-32787) at least once each year and replace if tube has cracks or shows other signs of deterioration. Testing and field operations have produced excellent results which indicate that automatic annual replacement of exhaust tube is not required.

1. Remove drive unit and engine from boat.
2. Remove gimbal housing from boat by removing screws which fasten inner transom plate and gimbal housing to boat.
3. Remove hose clamp which fastens exhaust tube to flange on gimbal housing.

NOTE: Exhaust Water Shutter Kit (B-46017A1) should be installed in flexible neoprene exhaust hose to help keep water from entering the exhaust manifold and combustion chambers of the engine under the following conditions: a) When stopping suddenly, thus causing following waves, b) when shutting off throttle suddenly and c) when launching a boat from a trailer (back end first). Later drive units have metal exhaust elbows which incorporate a water shutter.

4. Remove hose from flange. Hose is cemented to gimbal housing with a special sealer.
5. Remove old adhesive from flange with sandpaper. Be sure that surface is clean.
6. Roughen inside surface of exhaust tube, which is placed over flange, with sandpaper.
7. Mix contents of Exhaust Tube Sealer Kit (C-92-33749) as follows: Thoroughly mix 2 parts from tube "A" and one part of hardener from tube "B", using only the quantity which will be used immediately.
8. Apply sealer smoothly to surface of flange and inside surface of exhaust tube.
9. Push exhaust tube fully over flange.
10. Position tube so that it will not be kinked or rub on engine coupling when connected to elbow on manifold of engine.
11. Place hose clamp around tube and tighten securely.
12. Allow sealer to dry for 16 hours at room temperature.
13. Reinstall drive unit and engine.

EXHAUST ELBOW and SHUTTER REPLACEMENT

MerCruiser 120-140-160-165-888

1. After removing drive unit and engine, remove screws and lockwashers from gimbal housing to remove exhaust elbow and "O" ring(s). (Figures 4 and 5)

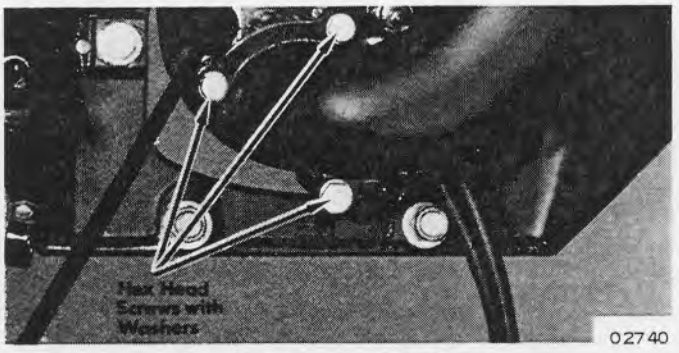


Figure 4. Exhaust Elbow and "O" Ring in Groove for 120-140-160-165

2. Remove exhaust bellows and remove holding support bracket for water shutter, if replacement is necessary.

NOTE: On "888", water shutters are located in exhaust separator.

3. Reassemble exhaust elbow by reversing disassembly procedure.

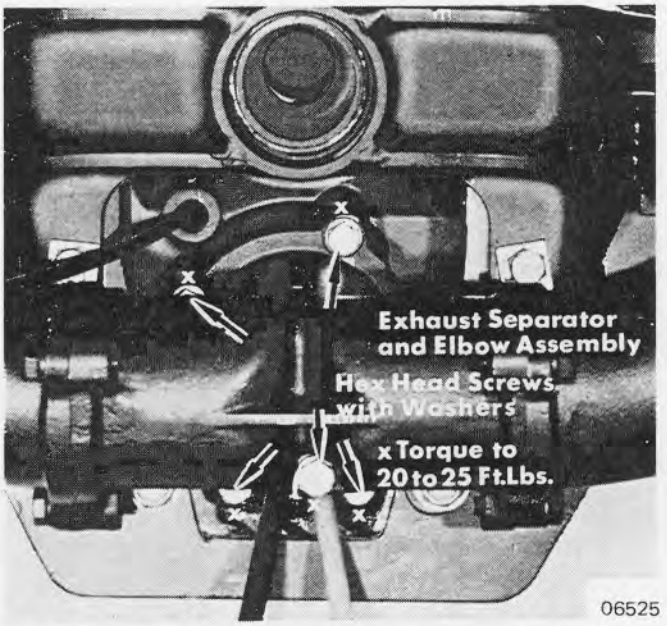


Figure 5. Exhaust Separator and Elbows for 888

4. Clean mating surfaces on elbow and gimbal housing.
5. Place "O" ring in groove of gimbal housing. (Figures 6 and 7)

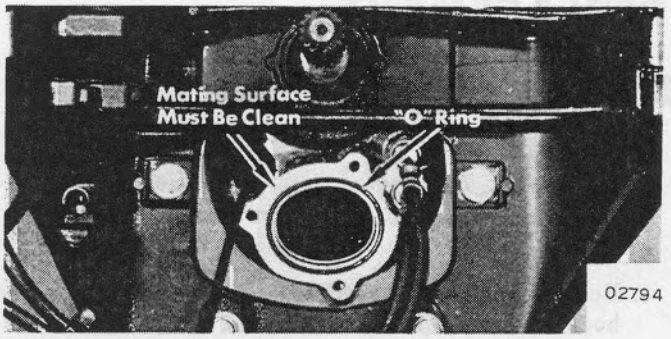


Figure 6. Positioning "O" Ring in Groove on 120-140-160-165

6. Reinstall elbow with screws and lockwashers, torquing them to 20-25 ft. lbs. (4.14-4.83mkg). Be certain that "O" ring remains seated in groove, properly sealing joint to prevent leakage.

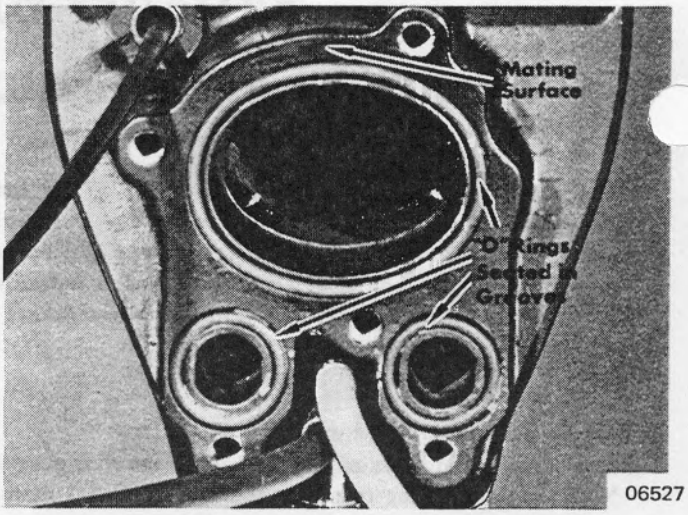


Figure 7. "O" Ring Locations for 888

REMOVE and REPLACE TILT STOP SWITCH ASSEMBLY

REMOVAL

1. Disconnect steering link rod from steering lever. (Figure 1)
2. Support drive unit with an overhead hoist and remove 2 gimbal ring to bell housing hinge pins.

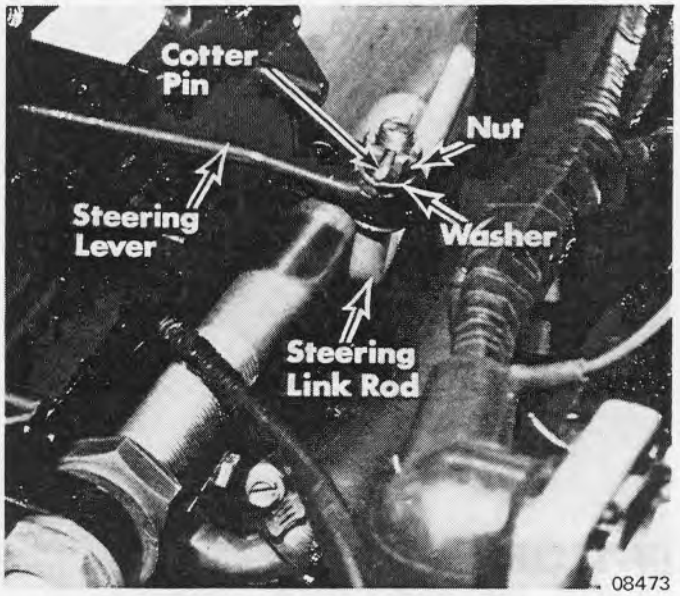


Figure 1. Steering Lever and Link Rod

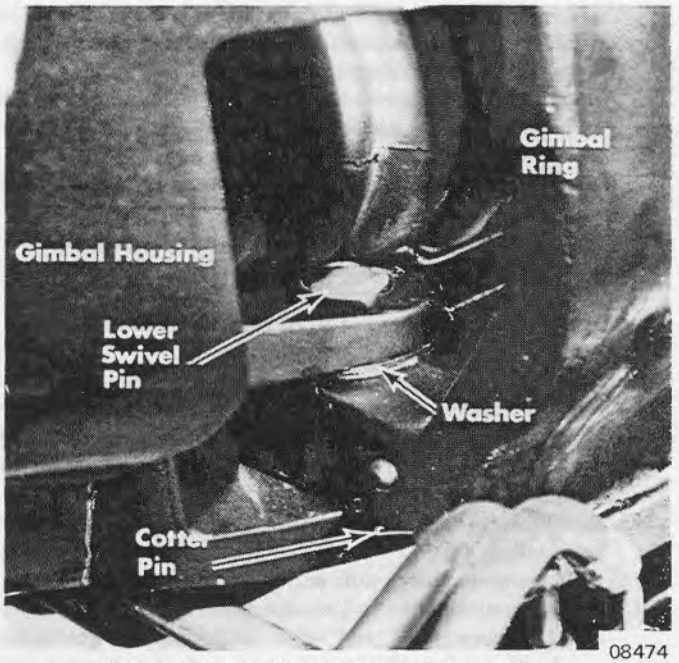


Figure 2. Lower Swivel Pin and Cotter Pin

3. Operate Power Trim in "up" direction (approximately 5" [12.7cm] cylinder ram movement) and pull bell housing and drive unit assembly away from gimbal housing as far as bellows will allow.
4. CAUTION: Be careful not to damage gimbal ring roller bearing when driving lower swivel pin with punch.

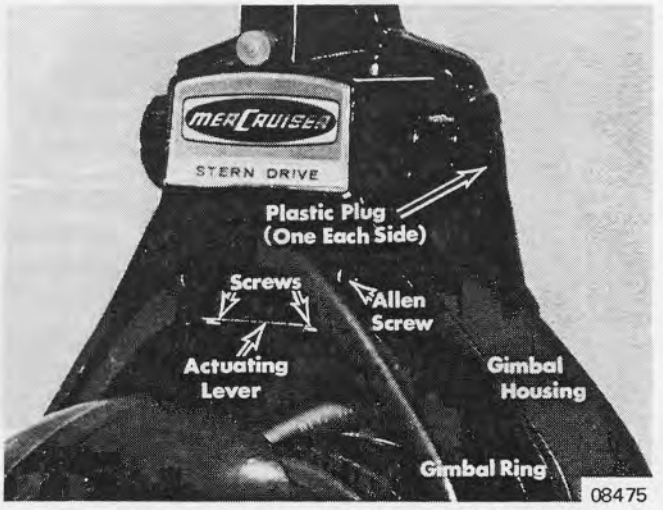
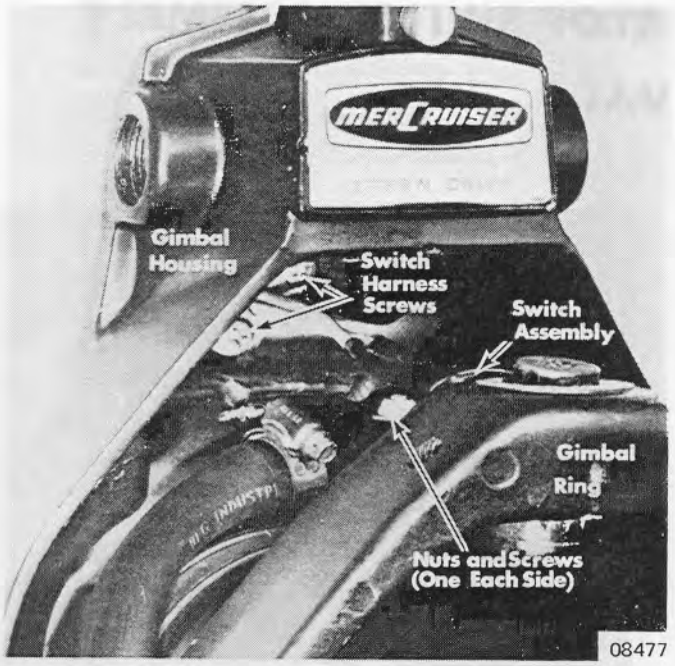


Figure 3. Actuator Lever, Allen Screws and Plastic Plugs

Remove cotter pin from lower swivel pin. (Figure 2) Drive swivel pin down with punch and hammer until cotter pin hole is protruding from gimbal housing. Then, insert small punch or like-object into cotter pin hole (one from each side) and pull pin from housing.

5. Remove 2 screws and stop switch actuating lever. (Figure 3)
6. Remove plug from end of upper swivel shaft (located under switch actuating lever). (Figure 3)
7. Remove upper swivel shaft allen screw and washer from side of gimbal ring. (Figure 3)
8. Remove 2 plastic plugs from upper end of gimbal housing (one each side). (Figure 3)
9. Insert wrenches thru holes (from which plastic plugs were removed) and remove steering lever to upper swivel shaft screw. (Figure 4)

Figure 4. Steering Lever and Brass Pipe Plug



10. Remove brass pipe plug from top of gimbal housing. Drive upper swivel shaft down (using a punch thru pipe plug hole) a sufficient amount to disengage shaft from gimbal housing. (DO NOT drive shaft all-the-way out, or bellows may be damaged.)
11. Pull gimbal ring away from gimbal housing a sufficient amount and remove 2 screws and nuts which secure switch in gimbal ring. (Figure 5) (Run Power Trim down to aid in positioning gimbal ring.)
12. Remove 2 screws, which hold switch harness to gimbal housing,and remove switch assembly. (Figure 5)

Figure 5. Tilt Stop Switch

INSTALLATION

1. Install new switch in gimbal ring. Switch leads must be positioned as shown in Figure 6, or leads may become shorted to gimbal ring.

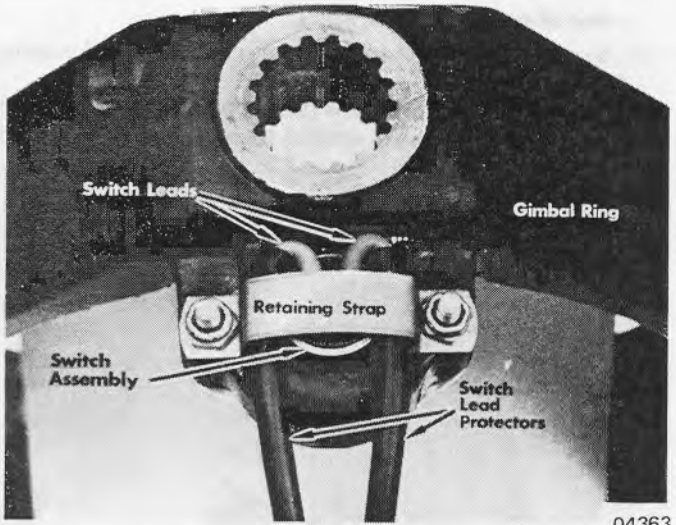


Figure 6. Switch Leads Installed

2. Insert switch harness thru gimbal housing and install 2 screws which hold switch harness to gimbal housing. (Figure 5)
3. Place gimbal ring in position in gimbal housing.
4. Place shim and steering lever in position (straight forward and install upper swivel shaft thru steering lever. (If difficulty is encountered when installing shaft, install lower swivel pin to align gimbal ring.)
5. Adjust height of swivel shaft to allow installation of allen screw thru side of gimbal ring. Torque screw to 20 ft. lbs. (2.77mkg). (Figure 3)
6. Install bolt thru steering arm and torque to 45 ft. lbs. (6.22mkg). (Figure 4)
7. Apply sealer to threads and install plastic plugs (one on each side of gimbal housing). (Figure 3)
8. Install plug in end of upper swivel shaft.
9. Install brass pipe plug in top of gimbal housing.
10. Install switch actuating lever. (Figure 3)
11. Install lower swivel pin, washer and cotter pin. (Figure 2)
12. Check clearance between gimbal ring and gimbal housing at lower swivel pin (.015" to .030" [.38mm to .76mm]). Adjust clearance (if necessary) by adding or removing washers from under steering lever.
13. Run Power Trim in "down" direction until hinge pins can be installed.
14. Install washers, hinge pins and hinge pin retaining pin.
15. Connect steering link rod to steering lever.
    a. On steering link rod with castle nut, torque nut to 20-25 in. lbs. (23-28.8 kg-cm) and, if necessary, back nut off slightly to install cotter pin. (Figure 1)
    b. On steering link rod with nylock nut, torque nut to 50-60 in. lbs. (58-69 kg-cm).

SECTION 6 - DRIVE SYSTEMS

MERCRUISER

PART B - MERCRUISER II

MERCURY MARINE

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MERCRUISER II (1.33:1) and (1.78:1) DRIVE UNIT

NOTE: Repair procedures for early 1.33:1 right hand and left hand propeller rotation units are noted: 1.78:1 and later 1.33:1 drive propeller rotation is determined by external adjustments.

1. Use special service tools where specified and common tools of proper fit when removing parts.
2. When bearings are removed from housings or assemblies, keep them together with original shims for replacement in reassembly; however, if a new part was added to the assembly, reshimming will be necessary to obtain proper bearing preload or gear lash. Refer to appropriate section of this MerCruiser Service Manual for procedures
3. Keep bearing assemblies and spacer components together for reassembly in removal order.
4. Bearings, gears and housings are different for 1.78:1 and 1.33:1 and must not be interchanged.
5. When holding housings or parts in a vise -- or by other means -- use blocks of wood and/or brass shields to prevent marring parts' surfaces. Since removal of pressed-on parts (bearings, gears, etc) require adapting appropriate mandrels and supports for the press used, do not apply force on the bearing cages, mating surfaces or edges which would mar or fail if force is applied.
6. Clean parts with cleaning solvent before inspection and perform repairs on a clean bench area. Foreign matter can cause false shimming indications and/or premature bearing failures. Lubricate parts with oil or grease to ease installation, retard rust, etc; except when installing oil seals, they require Loctite "A" (C-92-32609-1) to prevent lubrication seepage and hold seal securely in position.
7. Remember - "An ounce of prevention is worth a pound of cure" - during service/repair.

BEFORE BEGINNING REPAIR

Before disassembling, it is recommended that the drive unit remain mounted in a boat or be installed in a set of transom plates which are on a supporting stand, as shown in Figure 1. For information pertaining to installation of transom plates and drive unit, refer to "Installation" Section 2.

MerCruiser II 1.33:1 - Rotate drive 180°, release reverse locks and drain lubricant.

MerCruiser II 1.78:1 - Use tilt cylinders to tilt drive to ease removal of gear housing and to drain lubricant. Remove tilt cylinders only if complete drive shaft housing and gear housing are to be removed.

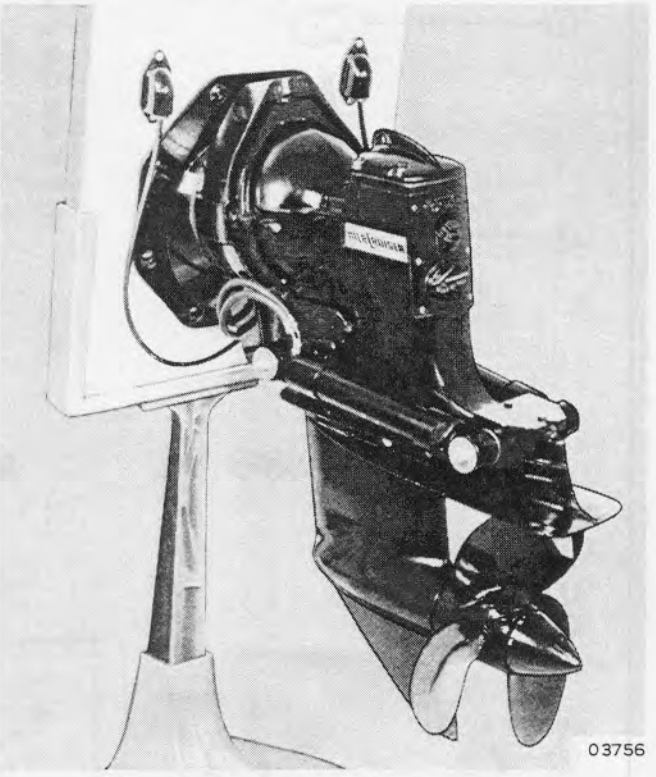
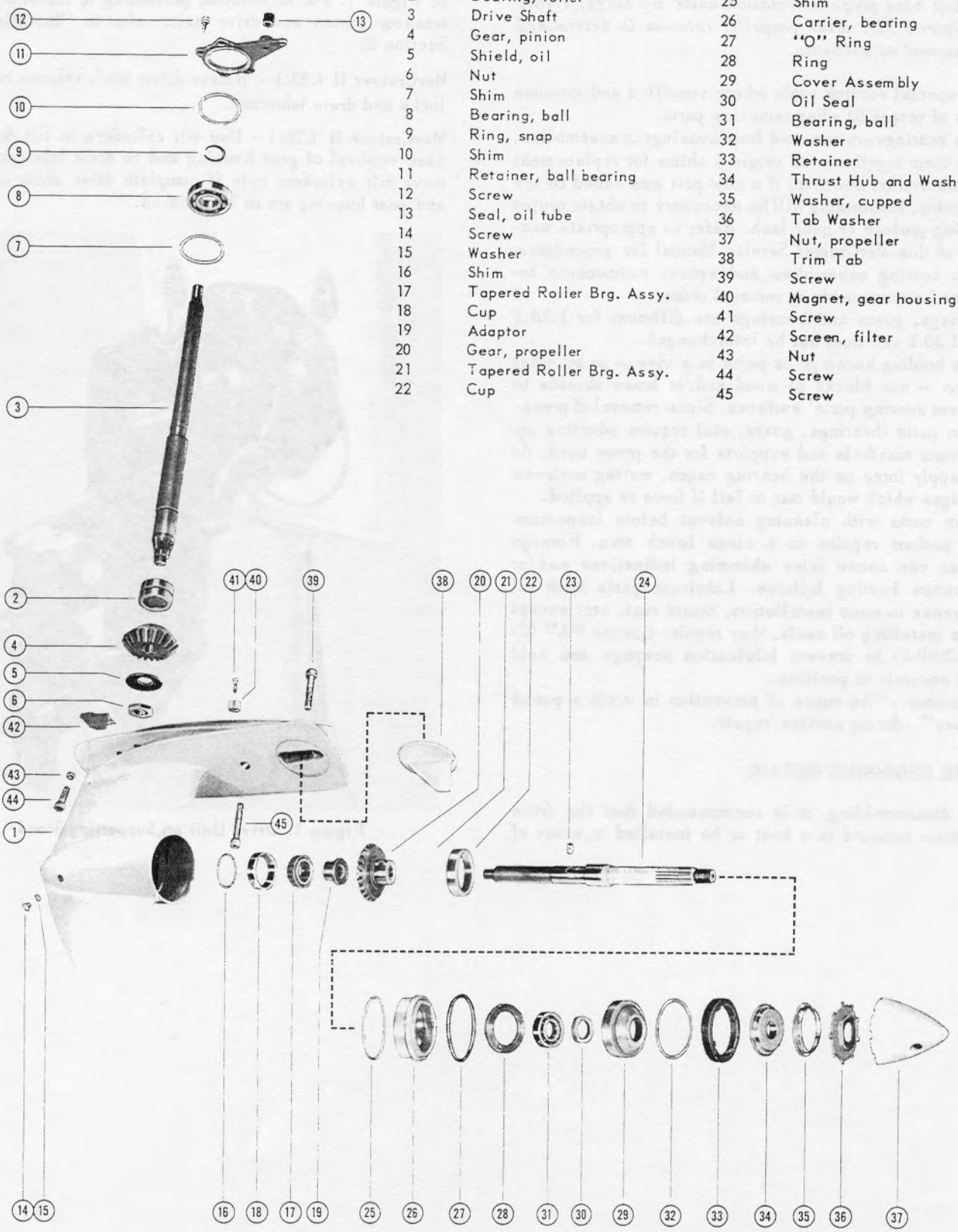


Figure 1. Drive Unit on Supporting Stand



1	Gear Housing Assembly
2	Bearing, roller
3	Drive Shaft
4	Gear, pinion
5	Shield, oil
6	Nut
7	Shim
8	Bearing, ball
9	Ring, snap
10	Shim
11	Retainer, ball bearing
12	Screw
13	Seal, oil tube
14	Screw
15	Washer
16	Shim
17	Tapered Roller Brg. Assy.
18	Cup
19	Adaptor
20	Gear, propeller
21	Tapered Roller Brg. Assy.
22	Cup
23	Pin, dowel
24	Shaft, propeller
25	Shim
26	Carrier, bearing
27	"O" Ring
28	Ring
29	Cover Assembly
30	Oil Seal
31	Bearing, ball
32	Washer
33	Retainer
34	Thrust Hub and Washer Assy.
35	Washer, cupped
36	Tab Washer
37	Nut, propeller
38	Trim Tab
39	Screw
40	Magnet, gear housing
41	Screw
42	Screen, filter
43	Nut
44	Screw
45	Screw

Figure 2. Gear Housing

GEAR HOUSING

REMOVAL

1. Remove propeller and trim tab.
2. Remove hex head cap screws (Figure 1) and allen head screws and hex nuts from cavitation plate area (Figure 2) to separate gear housing from drive shaft housing.

   NOTE: Reverse locks, shock and 180° rotation are not incorporated in the 1.78:1 drive, since it has Power Trim hydraulic system.

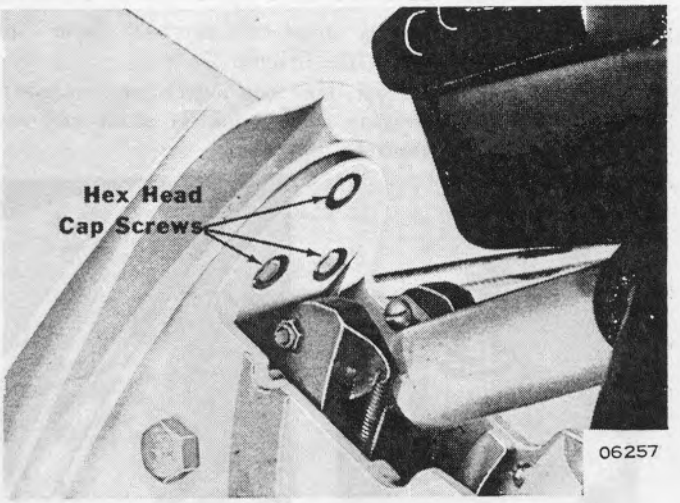


Figure 1. Hex Head Cap Screw Location

INSTALLATION

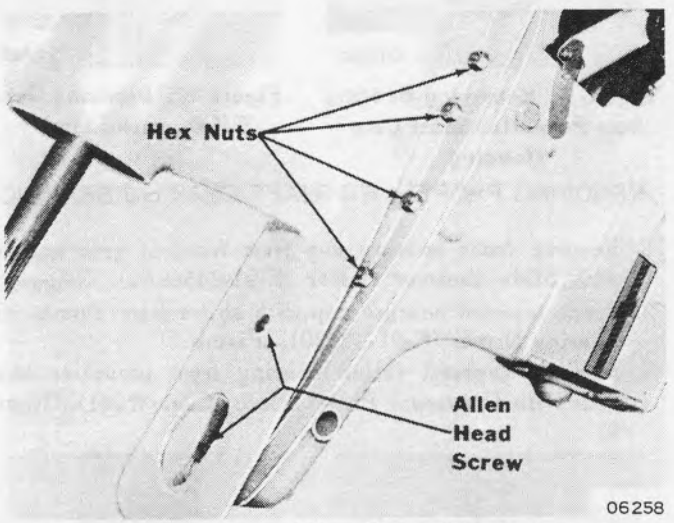


Figure 2. Cavitiation Plate Nut and Screw Location

1. Place new gasket on drive shaft housing to gear housing mating surface. Before joining gear housing, position trim tab allen head screw and, on later models, also install oil tube in drive shaft housing.

   NOTE: When replacing gear housing assembly complete on units below Serial No. 1602186, it is not necessary to install oil tube in gear housing, since earlier style drive shaft housing is not machined to accept the oil tube. Oil tube seal must be removed from ball bearing retainer. Also, it is not necessary to install oil tube in gear housing when late style drive shaft housing is replaced on units below Serial No. 1602186.

2. Join gear housing and drive shaft housing by inserting drive shaft thru sliding clutch, install nuts and screws, which were removed previously, and tighten securely.
3. Fill drive unit with fresh SUPER-DUTY Gear Lubricant (C-92-52650 tube or C-92-52655 qt.)

PROPELLER SHAFT DISASSEMBLY

REMOVING PROPELLER SHAFT SEAL and/or BEARING

1. Remove gear housing cover retainer with Gear Case Cover Tool (C-91-53126). (Figure 3)
2. Secure propeller shaft, then tap lightly and evenly on skeg and gear housing until propeller shaft and components can be removed. (Figure 4)

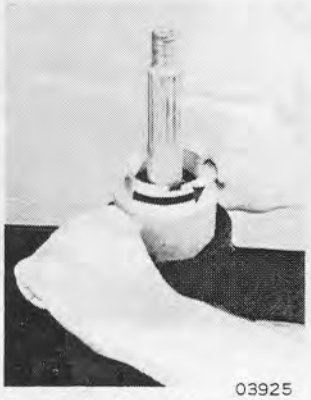


Figure 3. Removing Gear Housing Cover Retainer

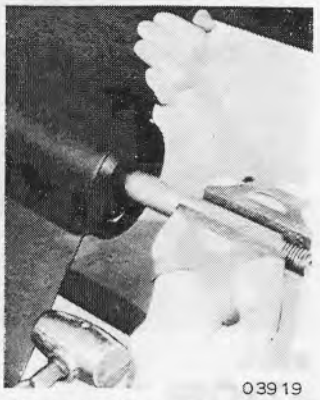


Figure 4. Removing Prop Shaft and Components

3. Remove gear housing cover and bearing carrier assemblies from propeller shaft. If gear housing cover is extremely tight on propeller shaft, use Universal Puller Plate (C-91-37241) to remove. (Figure 5)
4. Remove ball bearing retainer ring, then press oil seal and ball bearing out of cover. (Figure 6)

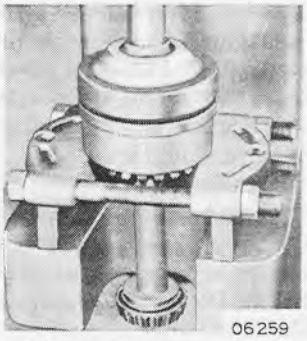


Figure 5. Removing Gear Housing Cover

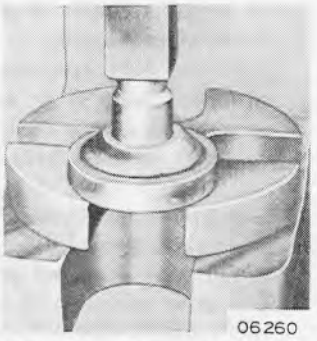


Figure 6. Removing Oil Seal and Ball Bearing

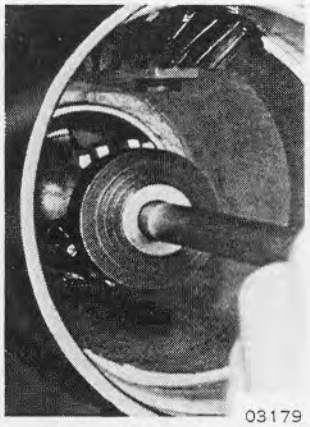


Figure 7. Removing Front Bearing Cup

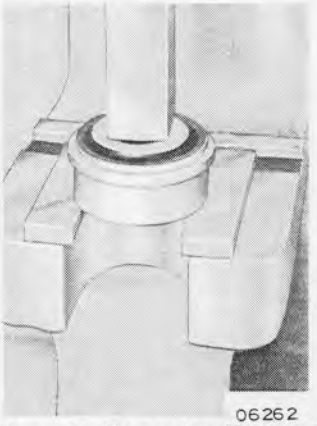


Figure 8. Removing Tapered Bearing Cup from Carrier

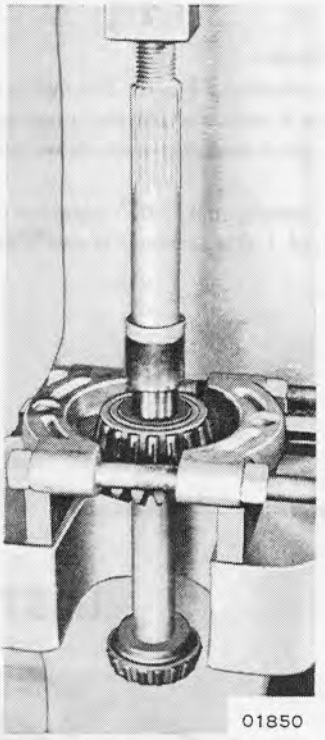


Figure 9. Removing Bearing from Propeller Shaft Gear Housing

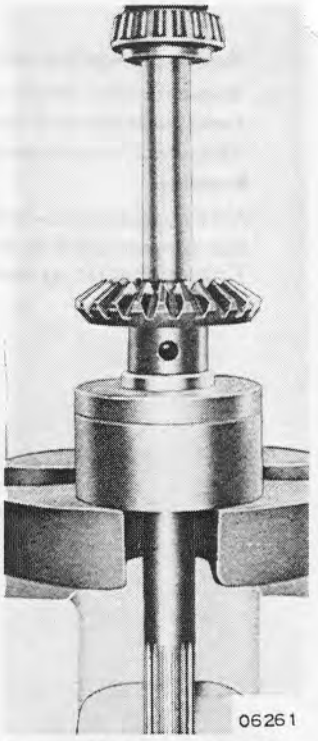


Figure 10. Pressing Gear Off Propeller Shaft

REMOVING PROPELLER SHAFT GEAR and BEARINGS

1. Remove front bearing cup from front of gear housing with Slide Hammer Puller (C-91-34569A1). (Figure 7)
2. Press tapered bearing cup with shims from carrier with Bearing Driver (C-91-32330). (Figure 8)
3. Remove tapered roller bearing from propeller shaft gear with Universal Puller Plate (C-91-37241). (Figure 9)

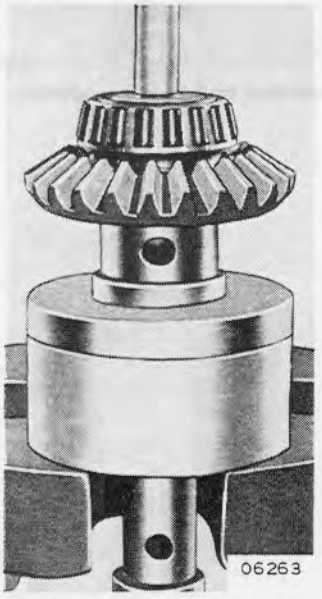


Figure 11. Pressing Adaptor Off Propeller Shaft

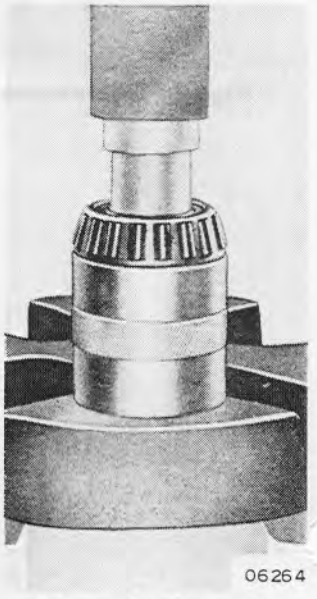


Figure 12. Removing Bearing from Adaptor

4. Remove propeller shaft gear, small tapered roller bearing and bearing adaptor as follows:
   a. Remove propeller shaft gear drive pin with 1/8" punch, driving pin out from opposite side of gear thru small hole.
   b. Support propeller shaft gear on Propeller Shaft Gear Tool (C-91-26376A1) and press gear toward tapered roller bearing. (Figure 10) Slide gear toward tapered roller bearing, allowing it to rest on gear, then press off bearing adaptor. (Figure 11)
5. Remove tapered roller bearing from adaptor. (Figure 12)

REASSEMBLY

1. Press oil seal into gear housing cover from inside with seal lips facing inside of cover.
2. Press ball bearing into cover with lettered side of bearing up and set bearing retaining ring into recess in cover.

REASSEMBLING PROPELLER SHAFT GEAR and BEARINGS

1. Replace shims and forward bearing cup in front of gear housing with Cup Driver Tool (C-91-31361), setting tapered end of cup against driver.
2. Place propeller shaft into center hole of cup driver, then use gear housing cover assembly to act as a guide to hold propeller shaft when pressing cup into position. (Figure 13)
3. Align propeller shaft and gear pin holes, then install propeller gear on propeller shaft by supporting gear with teeth down on Shaft Gear Tool (C-91-26376A1) and pressing shaft into gear until gear drive and shaft holes align. Lock gear to shaft with drive pin. (Figure 14)

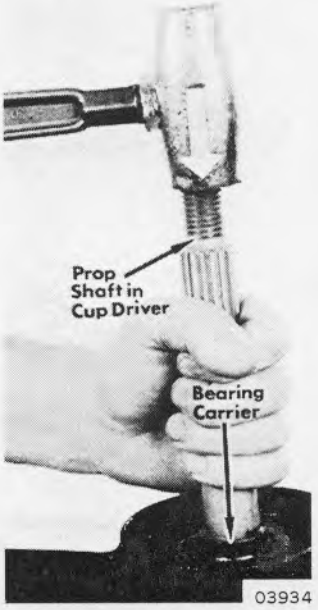


Figure 13. Installing Bearing Cup

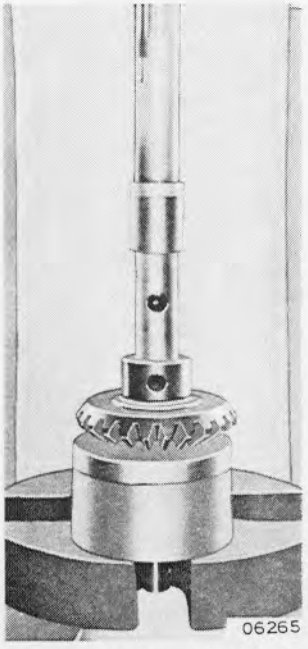


Figure 14. Pressing Shaft into Propeller Gear

4. Press large, tapered roller bearing on propeller shaft with large diameter of bearing toward gear, firmly seating bearing to gear. (Figure 15)
5. Press small, tapered roller bearing onto adaptor with large diameter toward shoulder until firmly seated (Figure 16)

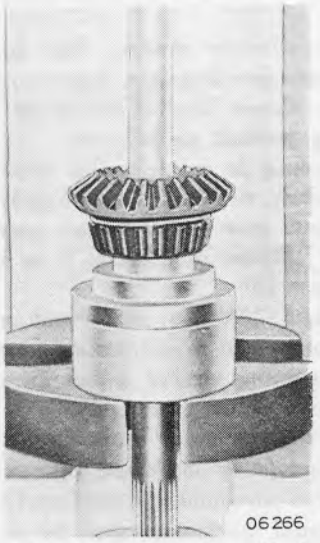


Figure 15. Pressing Shaft and Gear into Bearing

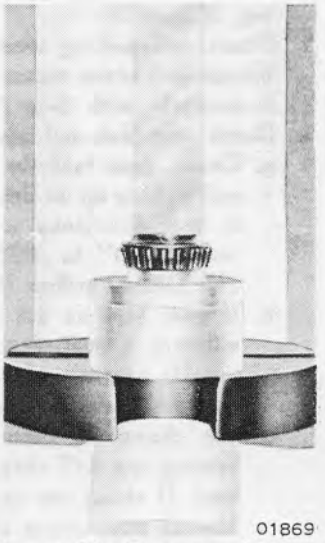


Figure 16. Pressing Adaptor into Bearing

6. Press adaptor and bearing over small diameter end of propeller shaft. (Figure 17)
7. Press large, tapered roller bearing cup into carrier with Bearing Cup Driver (C-91-31106). (Figure 18)

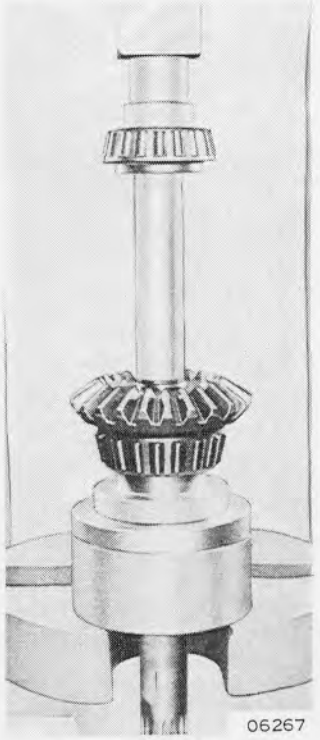


Figure 17. Pressing Adaptor on Shaft

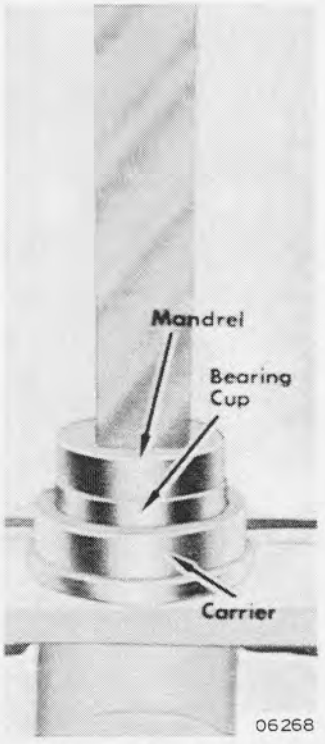


Figure 18. Pressing Cup into Carrier

REASSEMBLING PROPELLER SHAFT and COMPONENTS COMPLETE

1. Place propeller shaft assembly into gear housing.
2. Install bearing cup carrier and shims over propeller shaft, seating them in gear housing.
3. Place a new, rubber "O" ring in carrier recess.
4. Place Propeller Shaft Oil Seal Sleeve (C-91-32326) over propeller shaft and slide cover assembly over shaft until it bottoms on bearing cup carrier in housing. (Figure 19)
5. Place anti-galling washer in cover recess, then lubricate and screw retainer into gear housing, tightening it securely with Gear Hsg. Cover Tool (C-91-53126).
6. Check gear lash and bearing preload, as follows:
   a. Check gear lash by pushing in on propeller shaft and pulling up on drive shaft, rotating it very lightly in both directions to check gear lash between gear teeth (.008" to .012" [.203mm to .305mm]) at a 1½" (38mm) radius. (Figure 20)
   b. If gear lash is not within .008" to .012" add or subtract a sufficient amount of shims under front (small) bearing cup in housing and/or under drive shaft ball bearing to attain correct gear lash.
   c. Any change in shim thickness under front (small) bearing cup will change propeller shaft bearing preload. If shims are removed from under front (small) bearing cup, shims of equal thickness must be removed from under rear bearing carrier or, if shims are added under front bearing cup, shims of equal thickness must be added under rear bearing carrier. This is to maintain proper bearing preload, following in "d".
   d. Check propeller shaft bearing preload by trying to move propeller shaft in or out (fore and aft) without over-preloading the bearings. Proper bearing preload will allow shaft to rotate smoothly with slight resistance. If the propeller shaft rotates very freely or is hard to turn, the bearings are not properly preloaded.

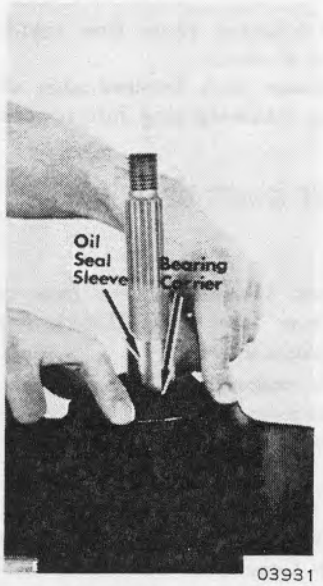


Figure 19. Installing Gear Housing Cover

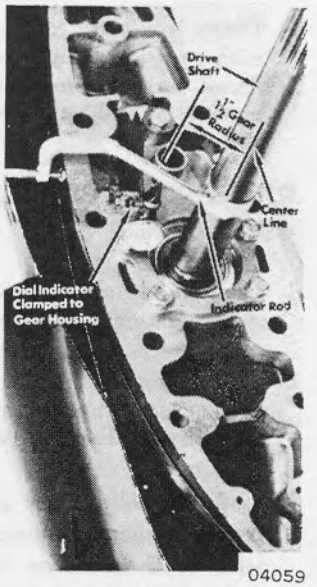


Figure 20. Checking Gear Lash

DRIVE SHAFT
REMOVAL

1. Use an old sliding clutch on drive shaft to keep shaft from rotating when removing pinion nut. (Figure 1)

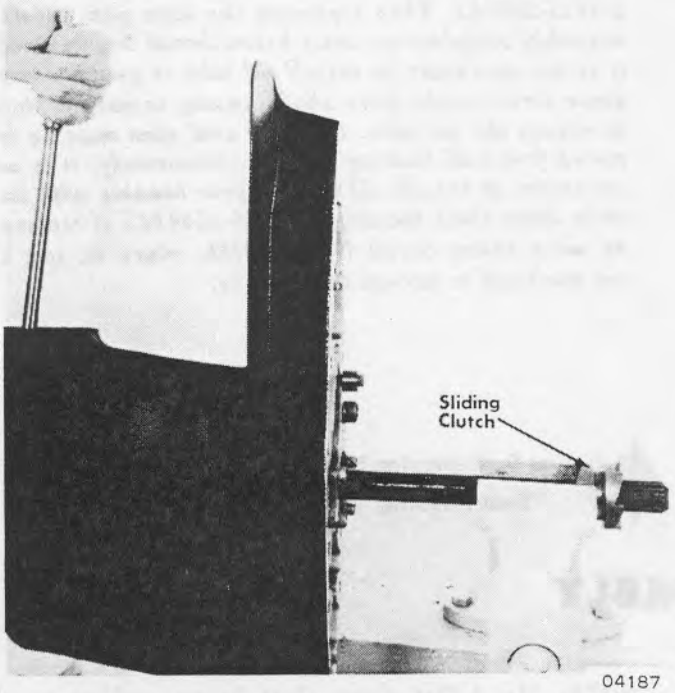


Figure 1. Removing Pinion Nut

2. Remove ball bearing plate and magnet with shims (Figure 2), then remove drive shaft with shims and pinion gear from housing. (Figure 3)

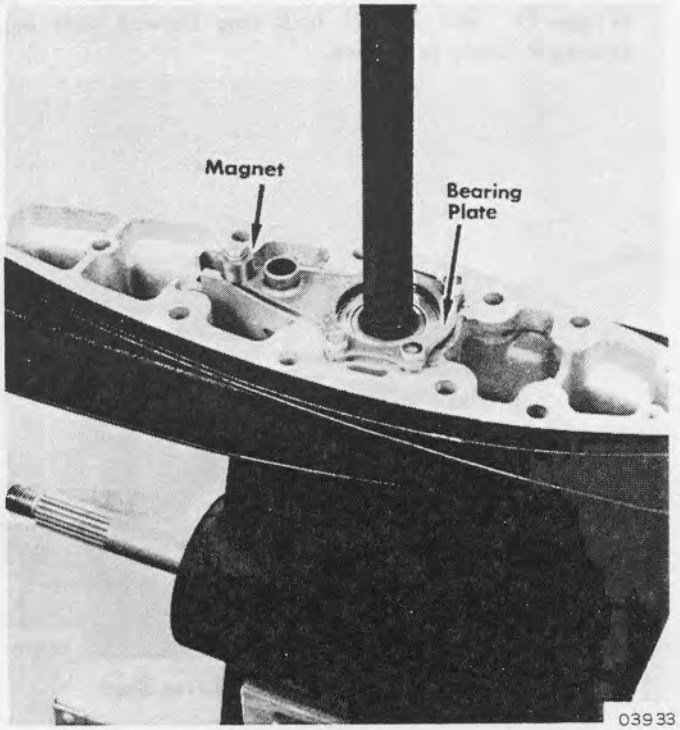


Figure 2. Ball Bearing Retaining Plate

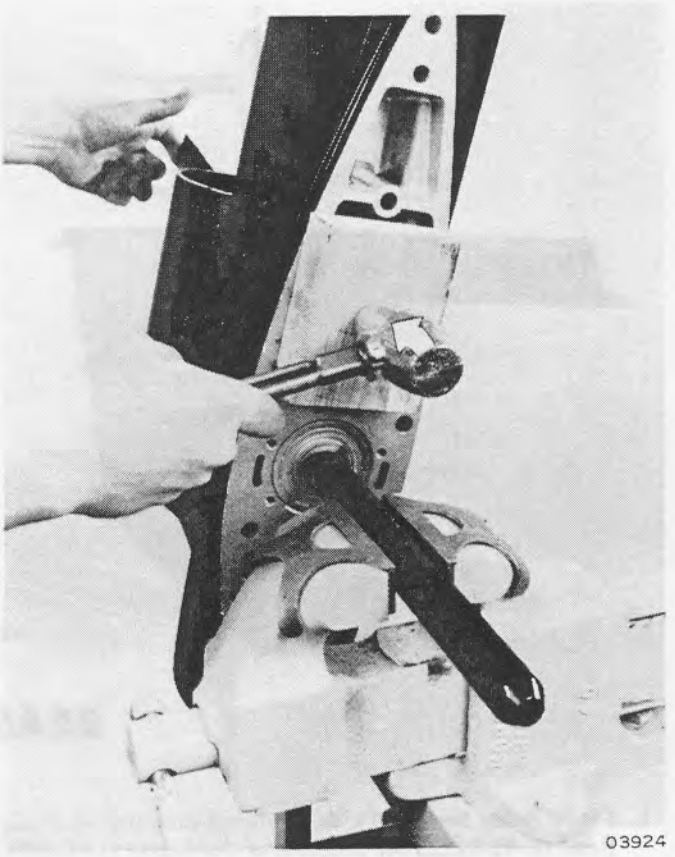


Figure 3. Removing Drive Shaft from Housing

NOTE: The drive shaft bearing rollers in the 1.78:1 drive could dislodge during disassembly, since the rollers are loosely stacked in their cage.

3. Remove bowed lock ring from drive shaft and tap drive shaft from ball bearing. (Figure 4)

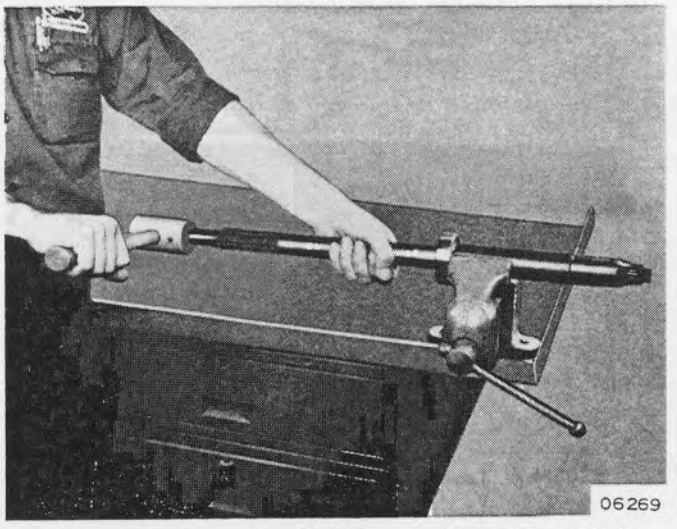
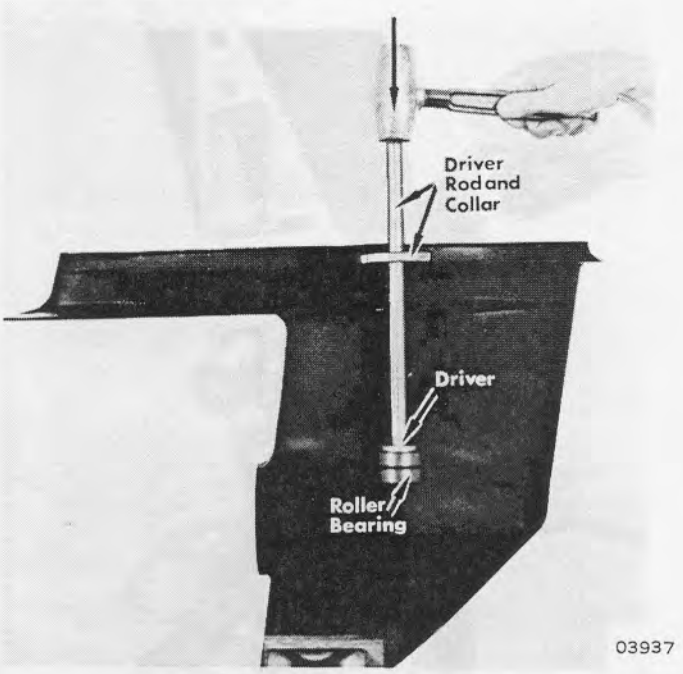


Figure 4. Removing Ball Bearing from Drive Shaft

4. Press or tap out drive shaft roller bearing with Driver Rod (C-91-32336A1) and Driver C-91-52393 for 1.78:1 gear housing or Driver C-91-32336 for 1.33:1 gear housing. (Figure 5)



NOTE: Replace gear housing assembly if bearing bore has been damaged or enlarged by drive shaft roller bearing failure. Repeated failure may occur if original bearing had turned in gear housing, thus enlarging the bearing bore surface to such an extent that the new roller bearing will fit loosely and move out of position.

NOTE: MerCruiser II 1.33:1 gear housing assembly complete (B-1625-2007A2) has been superseded by B-1625-2007A3. When replacing the later gear housing assembly complete on units below Serial No. 1602186, it is not necessary to install oil tube in gear housing, since earlier style drive shaft housing is not machined to accept the oil tube. Oil tube seal then must be removed from ball bearing retainer. Conversely, it is not necessary to install oil tube in gear housing with late style drive shaft housing (B-1544-2549A4), if replaced on units below Serial No. 1602186, since it, too, is not machined to accept the oil tube.

Figure 5. Removing Needle Bearing from Housing (Exposed View)

REASSEMBLY

1. Place roller bearing (with numbered side up) on Puller Head (C-91-32325 for 1.33:1 gear housing or C-91-52394 for 1.78:1 gear housing). Set Puller Shaft (C-91-31229) thru drive shaft housing into puller head, as shown in Figure 6.
2. Pull bearing into recess. The puller head will position bearing to correct depth.

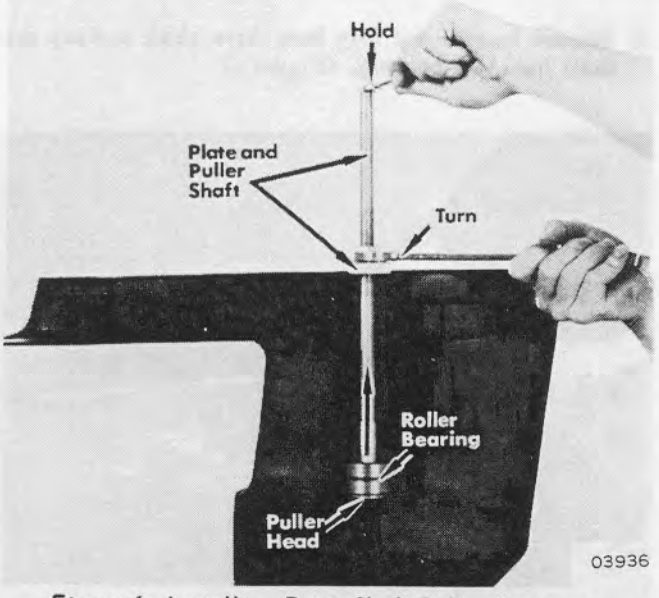


Figure 6. Installing Drive Shaft Roller Bearing

NOTE: The 1.78:1 drive shaft bearing rollers could dislodge after removing puller head, since the rollers are stacked loosely in their cage. Use New Multipurpose Lubricant (C-92-49588) to help hold the bearing rollers in place.

3. Seat ball bearing on drive shaft with closed side up (Figure 7) and install lock ring (bowed side up), seating it firmly in groove.

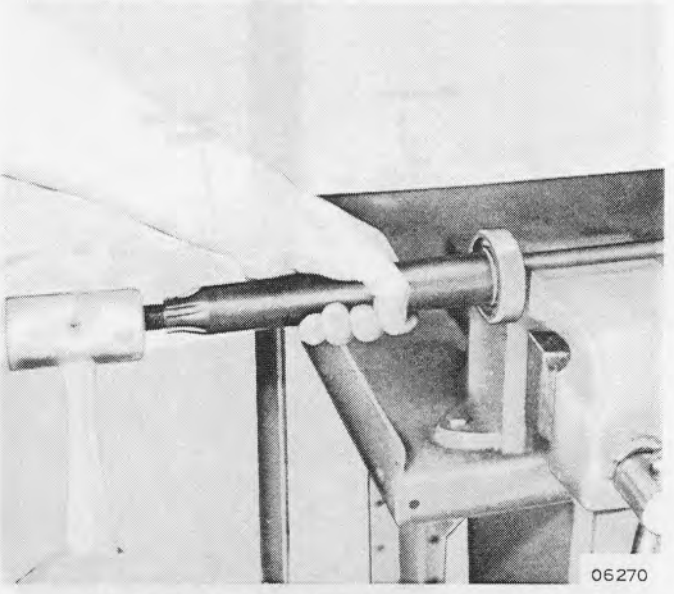


Figure 7. Seating Bearing on Drive Shaft

4. Lubricate outside of ball bearing, replace shims, check pinion bearing rollers for proper seating and install drive shaft into gear housing.

5. Use Ball Bearing Driver (C-91-32330) over drive shaft to seat bearing. A short (7½" □19cm□) length of 1½" (38mm) OD pipe makes an excellent driver. (Figure 8)

6. Replace shims on top of ball bearing, then reinstall bearing plate and torque screws to 20 ft. lbs. (2.76mkg), if original shims were reinstalled.

7. To determine correct shim thickness when parts have been replaced, it is necessary to over-shim retainer on top of ball bearing. Press retainer down firmly and, with a feeler gauge, measure gap between retainer and mating surface of gear housing. Remove shims equal in thickness to amount of gap between retainer and gear housing. This prevents bearing from moving up-and-down in housing.

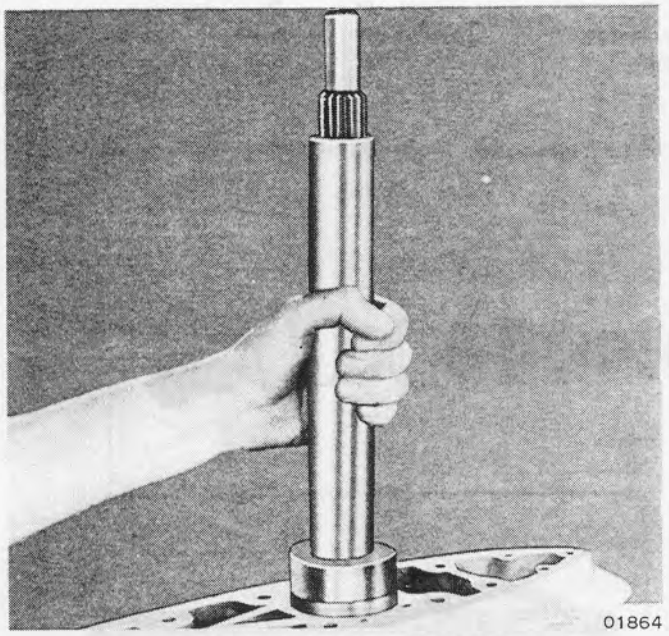


Figure 8. Seating Ball Bearing in Housing

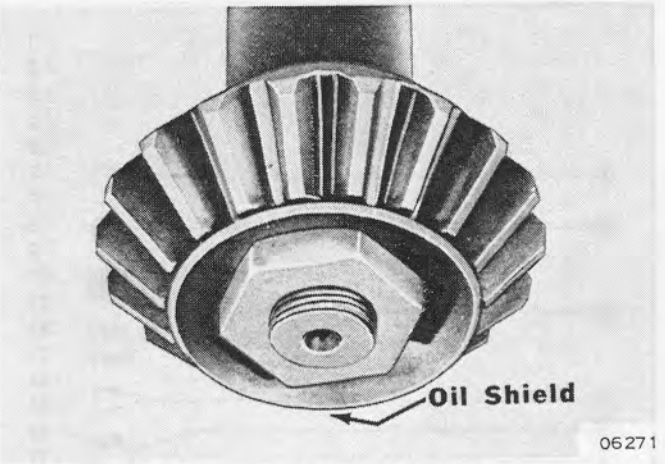


Figure 9. Oil Shield Location

8. Use an old sliding clutch on drive shaft to keep shaft from rotating when installing pinion gear and oil shield. (Figure 9) (Oil shield is not required on very early drive models.) Chamfered side of retaining nut faces gear. Torque nut to 150 ft. lbs. (20.7mkg). (Figure 10)
9. Complete "Propeller Shaft (and Component) Replacement", preceding, as necessary.

IMPORTANT: Refer to "Shimming Gear Housing for Gear Lash" and "Bearing Preload", preceding.

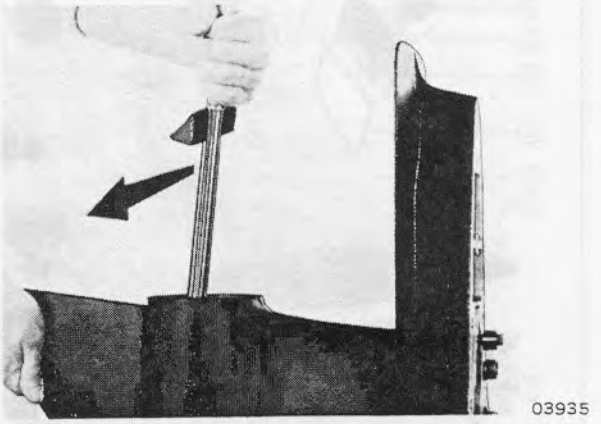
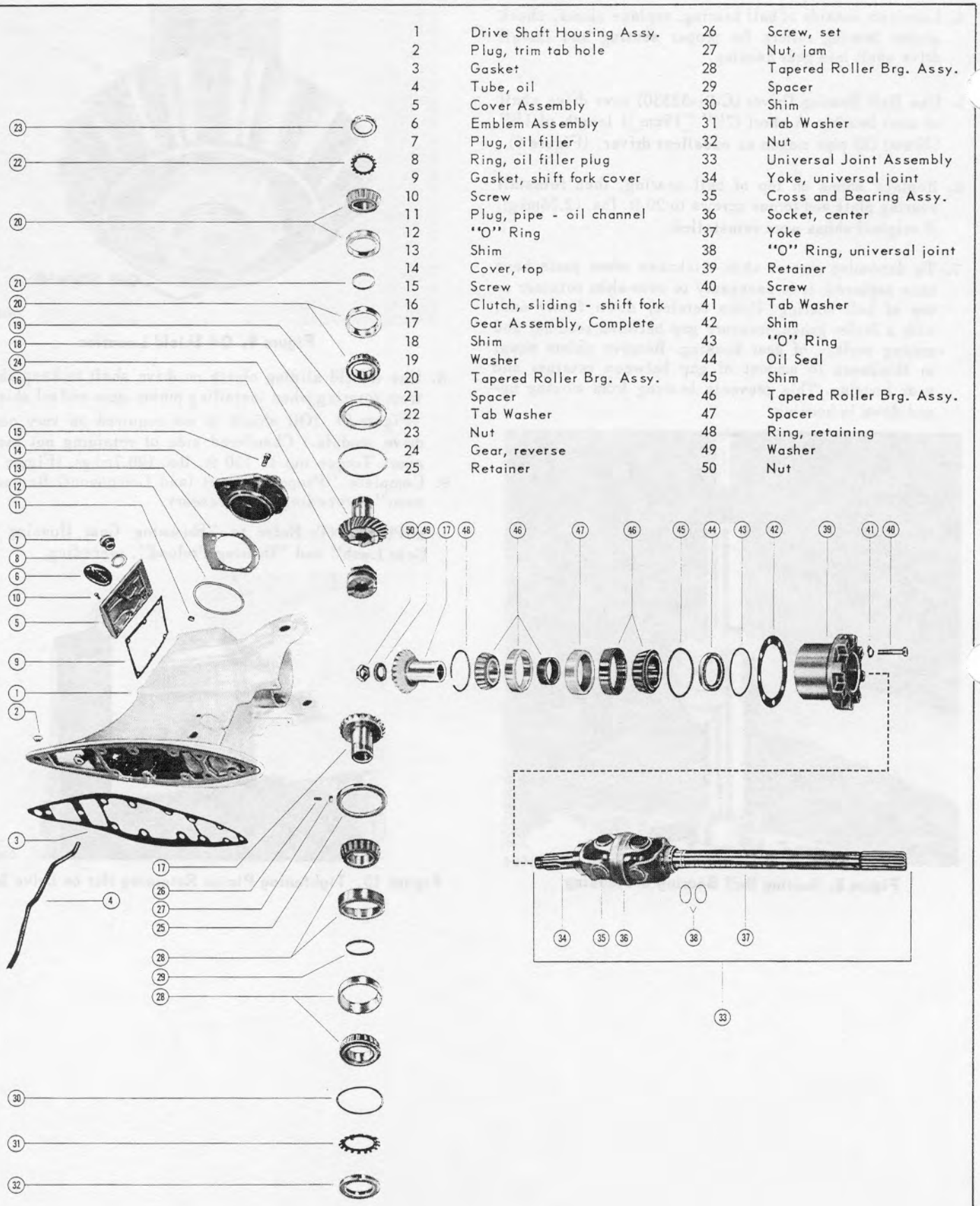


Figure 10. Tightening Pinion Retaining Nut on Drive Shaft



1	Drive Shaft Housing Assy.	26	Screw, set
2	Plug, trim tab hole	27	Nut, jam
3	Gasket	28	Tapered Roller Brg. Assy.
4	Tube, oil	29	Spacer
5	Cover Assembly	30	Shim
6	Emblem Assembly	31	Tab Washer
7	Plug, oil filler	32	Nut
8	Ring, oil filler plug	33	Universal Joint Assembly
9	Gasket, shift fork cover	34	Yoke, universal joint
10	Screw	35	Cross and Bearing Assy.
11	Plug, pipe - oil channel	36	Socket, center
12	"O" Ring	37	Yoke
13	Shim	38	"O" Ring, universal joint
14	Cover, top	39	Retainer
15	Screw	40	Screw
16	Clutch, sliding - shift fork	41	Tab Washer
17	Gear Assembly, Complete	42	Shim
18	Shim	43	"O" Ring
19	Washer	44	Oil Seal
20	Tapered Roller Brg. Assy.	45	Shim
21	Spacer	46	Tapered Roller Brg. Assy.
22	Tab Washer	47	Spacer
23	Nut	48	Ring, retaining
24	Gear, reverse	49	Washer
25	Retainer	50	Nut

Figure 11. Drive Shaft Housing Assembly

DRIVE SHAFT HOUSING

REMOVAL

Repair procedures for early and late model drive shaft housings are parallel, except where indicated.

- **If replacement of either forward or pinion gear is required on 1.33:1 drive, it must be replaced as a set.**
- **In right hand propeller rotation unit, forward gear is upper gear and reverse gear is lower gear. In left hand propeller rotation unit, forward gear is lower gear and reverse gear is upper gear.**
- **To identify forward gear from early model reverse gear, observe that forward gear has ramp teeth and reverse gear has straight, square teeth on clutch surface. Late models (Serial No. 1602186 and above) have ramp type teeth on clutch engagement surface of both forward and reverse gear.**
- **In order to generalize and clarify assembly procedures for both right and left hand rotation units, gears will be referred to as upper and lower gears rather than forward and reverse gears.**
- **Two different types of forward, reverse and pinion gear sets were used in MerCruiser production: (1) 35° spiral angle teeth sets and (2) 20° spiral angle teeth sets. (Figure 1)**

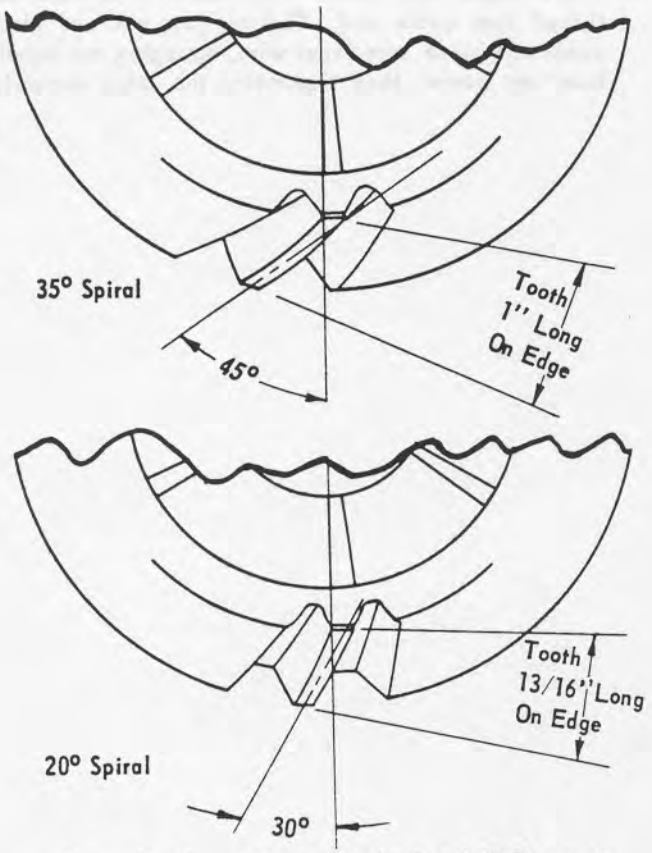


Figure 1. Visual Spiral Angle Teeth Differences

- **Tapered roller bearings, matching cups and spacers, which are assembled on upper, lower and pinion gears, must be replaced in sets so that bearings will have correct amount of pre-load when assembled on gears.**

REMOVING COMPLETE DRIVE SHAFT HOUSING ASSEMBLY

1. Disconnect shift cable, then remove end guide by loosening 2 square head set screws and pulling guide away from cable. Loosen hex head jam nut on cable end and screw insert out to remove it.
2. Loosen hose clamp which holds universal joint bellows to drive shaft housing and shift cable bellows from gimbal housing. Slide bellows away from housing cautiously to avoid damage.

   NOTE: Remove shock absorber anchor bolt and rotate unit to vertical position on 1.33:1 drive. On 1.78:1 drive, remove trim cylinders.

3. Drive out retaining pins, which anchor hinge pins, with long punch (some models have cotter pins), then remove hinge pins with Slide Hammer (C-91-34569A1) and adaptor (C-91-36060). (Figure 2)

   NOTE: Some early 1.33:1 drives require removal of grease fittings in hinge pins before hinge pins can be removed.

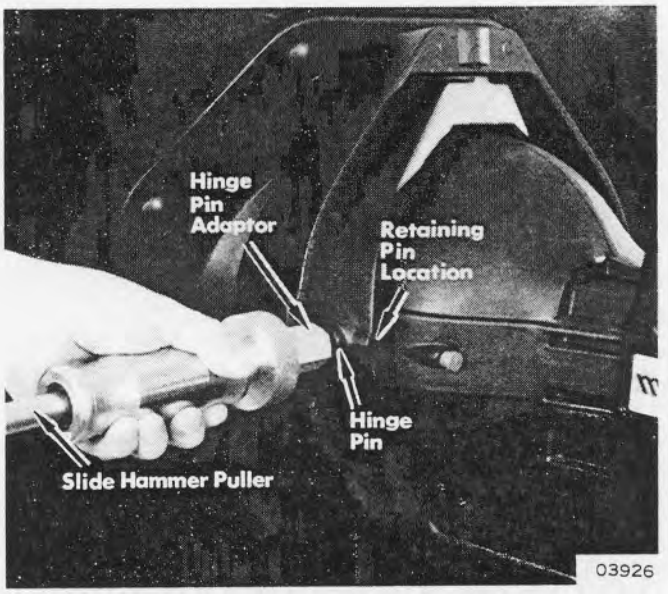


Figure 2. Removing Hinge Pins

4. Lift up and pull drive shaft housing assembly away from gimbal ring and housing.

INSTALLATION

NOTE: Universal joint cross bearings, gimbal bearings, bellows or gimbal housing may be repaired at this point. Refer to instructions, following.

1. Lift drive shaft housing so that universal joint shaft is in line with flexible mounted ball bearing in gimbal housing.
2. Insert unit shift cable thru its bellows. Place universal joint shaft thru bearing just far enough so that bellows end may be fastened with hose clamps.

   NOTE: Lubricate hinge and retaining pins with Anti-Corrosion Grease.

3. Slide drive shaft housing in until hinge pin holes are aligned. (Figure 3) Place anti-galling washers between drive shaft housing and gimbal ring and install hinge pins.
4. Replace hinge pin retaining pins and grease fittings, if applicable, then reinstall shock and anchor bolt or trim cylinders.

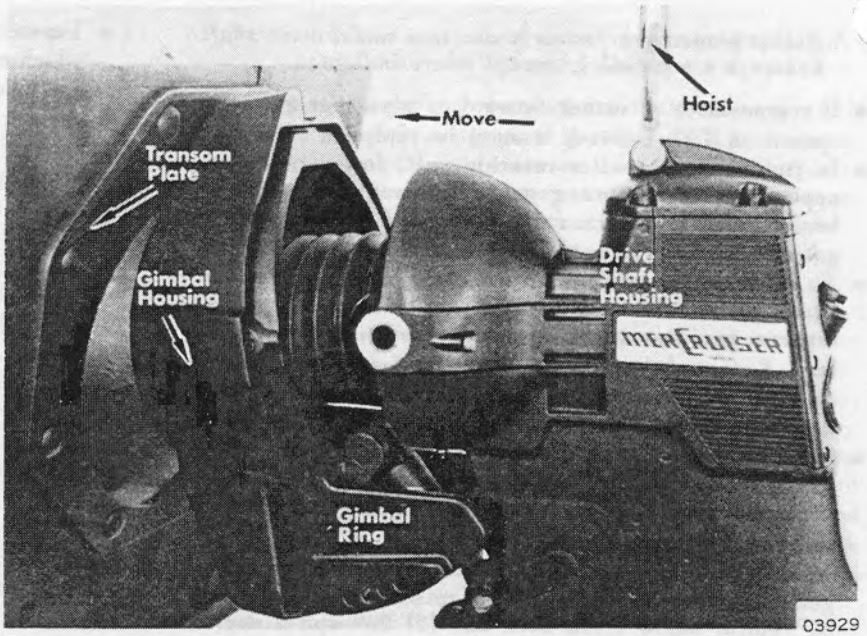


Figure 3. Installing Drive Shaft Housing in Gimbal Ring

5. Place cable end insert over inner core wire and thread into cable end. Tighten jam nut and place cable end guide over inner wire, snugging one square head set screw, then tightening the other securely.

SHIFTING and REVERSE LOCK MECHANISM

REMOVAL

1. Remove rear cover to drive shaft housing.
2. Remove nut from machine screw which passes thru shifter fork. Place wide edge of screwdriver between top surface of shift fork and edge of drive shaft housing. Push in on shift cable end guide until screw is free. On LEFT HAND propeller rotation units (early models with Serial No. 1602185 and below), pull out on shift cable end guide until screw is free.
3. Remove shift fork and sliding clutch from housing.
4. Remove shift cable end guide by loosening the 2 square head set screws and pulling guide away from cable. To remove cable end insert, loosen hex head jam nut on insert.
5. Remove inner core wire from shift cable by removing set screw in end of gear rack. Push inner wire out of gear rack from opposite end of cable until wire can be drawn out.
6. On MerCruiser 1.33:1 drive only, remove cotter pin that passes thru reverse lock cam shaft, then pull cam and shaft assembly from housing, being careful not to lose the reverse lock shaft gear which will be loose in gear rack. Refer to disassembly of shifter fork actuating mechanism, following.
7. Loosen clamps which hold universal joint bellows to drive shaft housing and shift cable bellows to gimbal housing. Slide bellows away from housing.
8. Drive out retaining pins, that anchor hinge pins, with long punch (some models have cotter pins), then remove hinge pins with Slide Hammer Puller (C-91-34569 A1) and adaptor (C-91-36060). (Figure 2, preceding)

NOTE: Some early drives require removal of grease fittings in hinge before hinge can be removed.

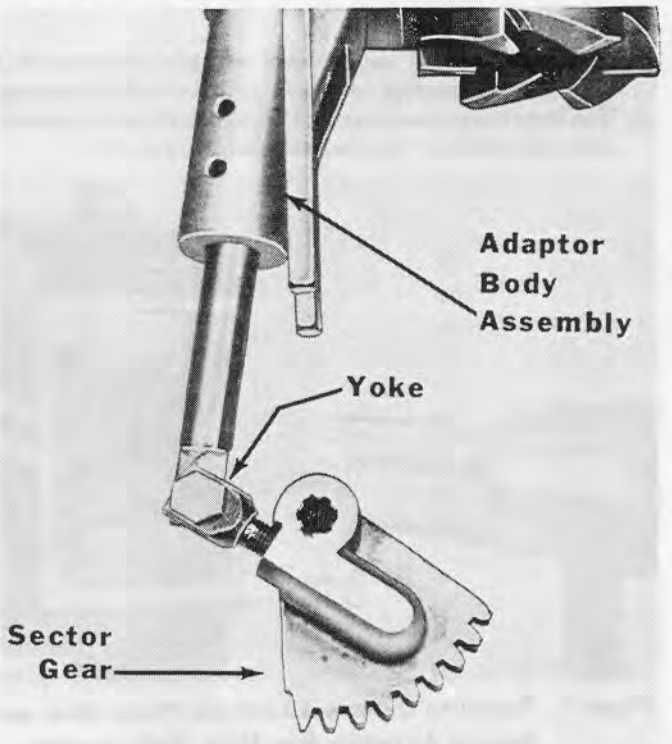


Figure 4. Removing Sector Gear 01903

DISASSEMBLY

1. Remove sector gear from rack guide by removing cotter pin which passes thru splined shaft.
2. Push shaft out of gear and rack guide.
3. Remove sector gear to shifter fork link and spring by removing screw and nut.
4. Remove hex head cap screws and tab washers which secure guide to housing.

   NOTE: Newer models (Serial No. 1602186 and above) have an adaptor body assembly in place of the shifter fork link and spring. (Figure 4)

REASSEMBLY

(STERN DRIVE SERIAL NO. 1602185 and BELOW)

1. Place shifter fork link inside its spring with round hole in link on same end as loop in spring. (On LEFT HAND propeller rotation unit, spring will have a loop in both ends. Place link thru spring so that elongated hole is opposite sector gear.)
2. Place hex head machine screw thru link and thru loop in spring, flat washer and sector gear.
3. Place elastic stop nut on screw and tighten. Back nut off ½-turn so that link and spring may pivot freely.
4. Place splined shaft thru rack guide, sector gear, reverse lock gear and washer.
5. Place cotter pin thru splined shaft between washer and reverse lock gear. Bend ends of cotter pin around shaft and check assembly for free movement.

(STERN DRIVE SERIAL NO. 1602186 and ABOVE)

1. Screw yoke all the way into sector gear, then back out 3 complete turns.

   NOTE: If shifter fork will not travel freely when in position, rotate yoke 180°.

2. Attach adaptor body assembly to yoke with screw and elastic stop nut.
3. On 1.33:1 drive only, place splined shaft thru rack guide, sector gear, reverse lock gear and washer. Place cotter pin thru splined shaft between washer and reverse lock gear. Bend ends of cotter pin around shaft and check assembly for free movement.

UNIVERSAL JOINT, PINION GEAR and BEARING ASSEMBLIES

REMOVAL

1. Remove hex head cap screws and tab washers which hold pinion bearing retainer to drive shaft housing.
2. Tap lightly against center of pinion shaft until universal joint and retainer can be removed. (Figure 1)

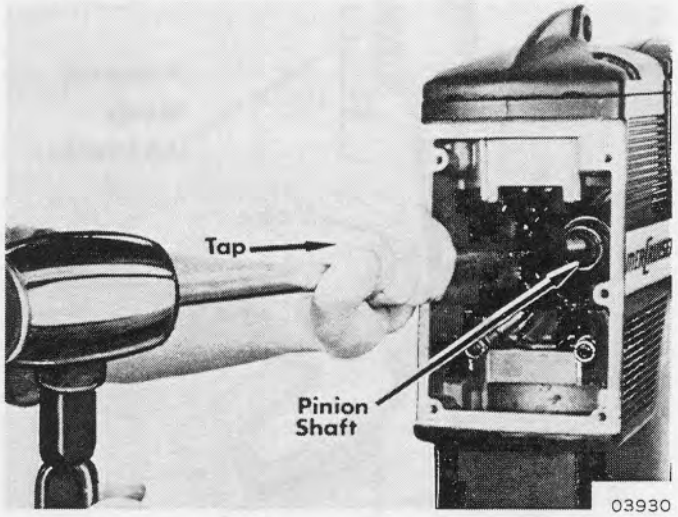


Figure 1. Removing Universal Joint and Pinion Gear and Bearing Assembly from Drive Shaft Housing

3. When removing tapered roller bearings, bearing cups and spacers from pinion gear, they must be kept in a set, as shown in Figure 2. If it is necessary to install new bearings on pinion gear, a complete bearing set, consisting of 2 tapered roller bearings with matching cups and 2 spacers, must be installed. On 1.33:1 drives, forward and pinion gears are assembled in matched sets. They cannot be replaced singularly, thus, if either of the gears require replacement, a gear set must be installed.

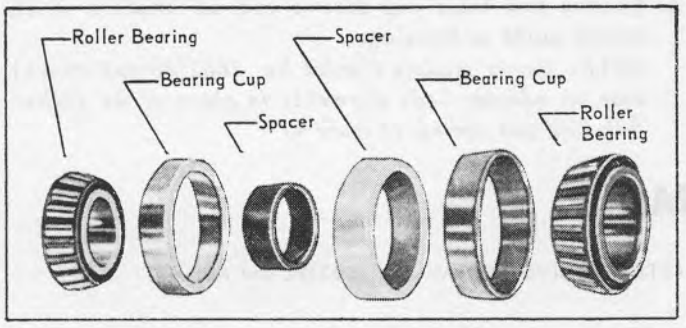


Figure 2. Bearing Set, Pinion Gear

4. Remove pinion nut with 1¼" socket and flex handle (Figure 3)

5. Lift pinion gear, washer and tapered roller bearing off shaft. Remove bearing cup retaining ring from groove in pinion bearing retainer.

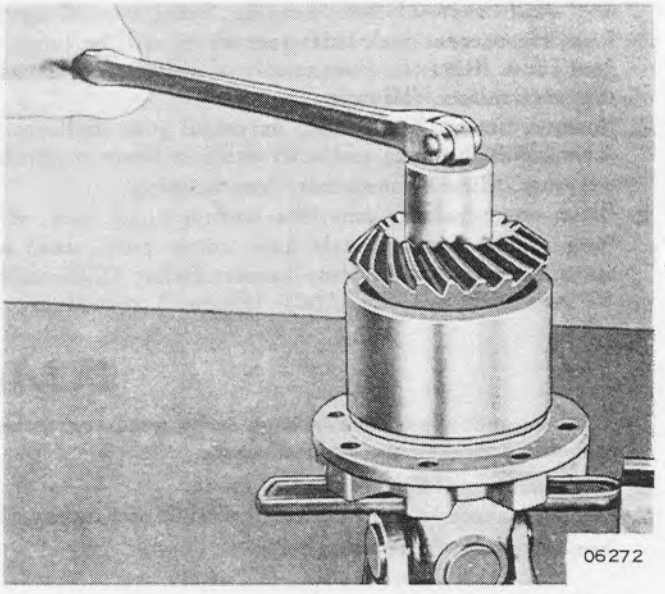


Figure 3. Removing Pinion Gear Retaining Nut

6. Lift pinion retainer off universal joint shaft and press tapered roller bearing, 2 tapered bearing cups, shims and 2 spacers and seal out of retainer at the same time. (Figure 4)

REASSEMBLY

1. Press oil seal (with a coat of Loctite "A" [C-92-32609] on outer surface) in bearing retainer with lips of seal toward inside of retainer.
2. Place bearings and spacers on pinion gear in following order: Tapered roller bearing with large diameter toward back of gear, tapered bearing cup over roller, cone spacer, large spacer, bearing cup with large diameter up and tapered roller bearing in cup.

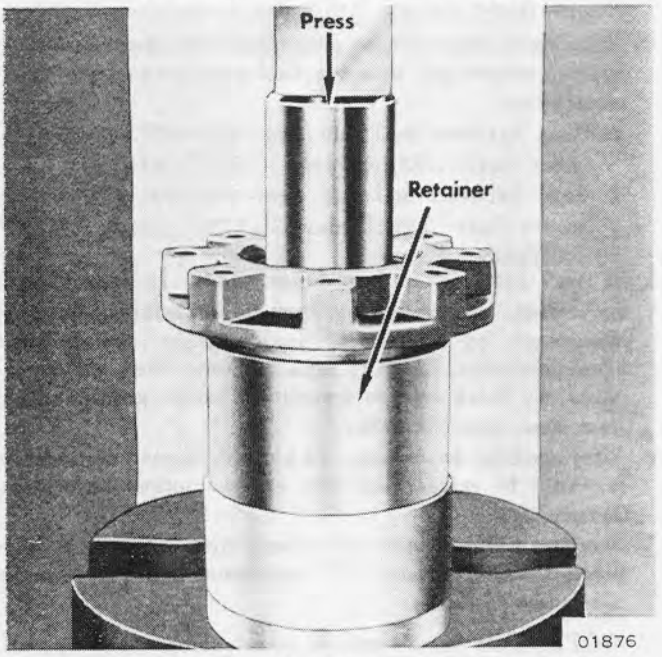


Figure 4. Pressing Bearing, Cups and Spacer from Retainer

IMPORTANT: Do not interchange tapered roller bearings and cups, as they are matched sets.

3. Support gear with teeth down. Shims should not be placed inside retainer at this time. Place retainer on top of bearings, then press on retainer until it bottoms. (Figure 5)

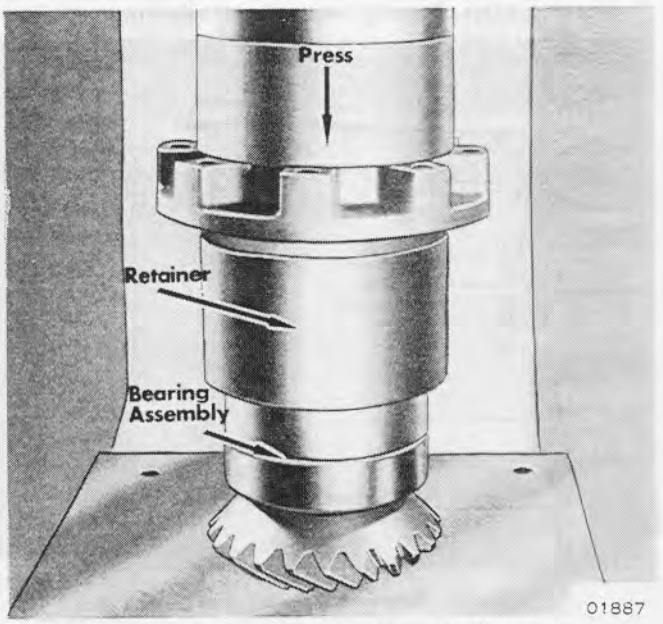


Figure 5. Pressing Bearing Cups in Retainer

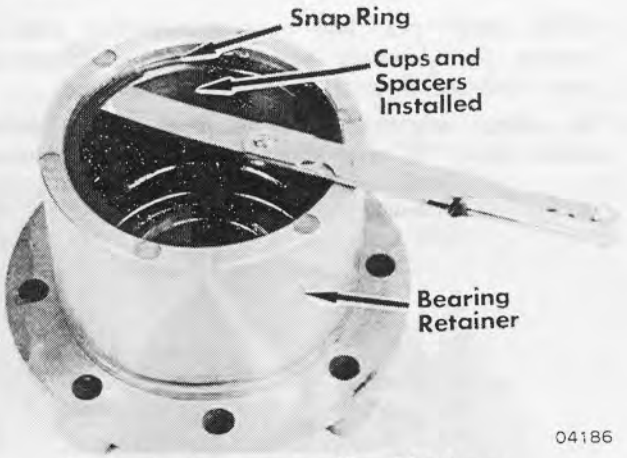


Figure 6. Determining Shim Thickness

4. Firmly seat retaining lock ring in groove in bearing retainer after removing gear, spacer and tapered roller bearing. Measure gap between snap ring and bearing cup with feeler gauge to determine shim thickness required under bottom bearing cup.

5. Remove bearing cups, roller bearing and spacer from retainer (refer to removal of universal joint, pinion gear and bearing assemblies, preceding). Install shims equal to feeler gauge reading. (Figure 6)

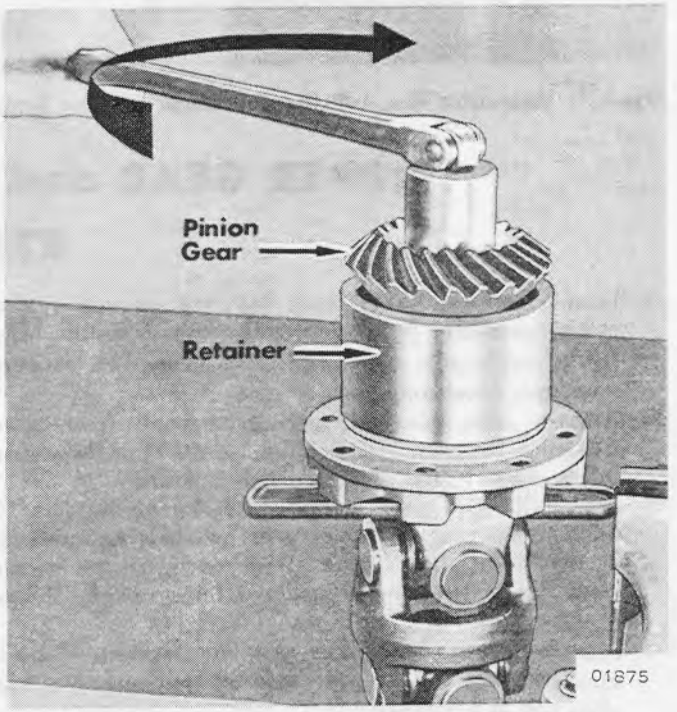


Figure 7. Installing Pinion Gear Retaining Nut

6. Replace bearing cups, spacers and bearings in retainer, then secure lock ring in groove.

7. Place retainer on universal joint shaft with washer (bowed side away from gear) and torque nut to 200 ft. lbs. (27.6mkg). (Figure 7)

SHIMMING PINION BEARING RETAINER

NOTE: Lower gear and bearing assembly must be removed for shimming pinion. Refer to "Removing Lower Gear and Bearing Assembly", following.

1. The shims, originally removed from pinion bearing retainer (less "O" ring) should be replaced on retainer.

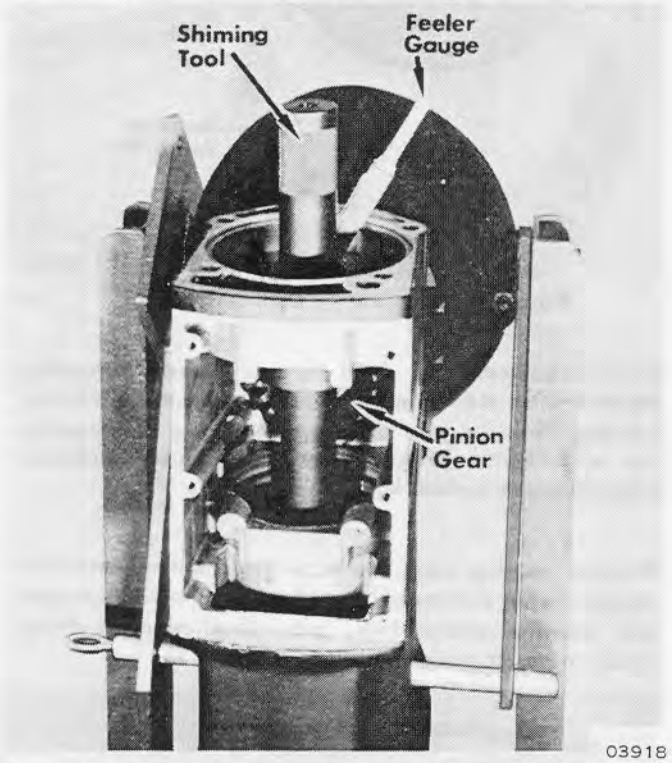


Figure 1. Measuring Gap with Feeler Gauge - Pinion Gear

2. Slide retainer into drive shaft housing and tighten in place by torquing hex head screws to 30 ft. lbs. (4.14mkg).
3. Place Pinion Shimming Tool (C-91-52002 for 1.78:1 drive or C-91-32334 for 1.33:1 drive) into drive shaft housing thru top cover opening and rotate tool so that correct diameter hole is directly over pinion gear. (Figure 1) with feeler gauge, measure gap between flat surface of pinion gear tooth and face of tool. (Figure 1)
4. To assure proper pinion gear mesh with upper and lower gears, proper gap between tool surface and gear teeth should be:
   a. Gap between tool and gear with 35° spiral angle gear (early 1.33:1 drives) - .032" (.813mm).
   b. Gap between tool and gear with 20° spiral angle gears (later 1.33:1 and all 1.78:1 drives) - .025" (.635mm)
5. If gap between tool and gear tooth is greater than specified, remove shims from under retainer equal in thickness to amount of feeler gauge reading over specified size. If gap is less than specified, add shims equal in thickness to amount of feeler gauge reading less than specified size.
6. After making any change in shim thickness, the retainer must be reinstalled with screws torqued before re-measuring gap.
7. Remove retainer with all shims when correct gap has been attained. Place "O" ring around retainer and set assembly aside.

NOTE: Mark the 2 teeth on pinion gear with machinist's blueing to aid in matching upper and lower gear teeth on the 1.33:1 drive.

UPPER GEAR and BEARING ASSEMBLY REMOVAL

1. Remove screws, which hold top cover assembly, then rotate assembly 90° by tapping with a mallet. Tap lightly and evenly with a mallet on underside of cover to remove cover and shims.
2. Remove upper gear and bearing assembly from cover with Slide Hammer Puller (C-91-34569A1) or Universal Puller Plate (C-91-37241) on later models.
3. Place sliding clutch on spline of Wrench Adaptor (C-91-32332A1) and set upper gear and bearing assembly on top of sliding clutch. With early model sliding clutch, install a spacer under sliding clutch. (Figure 2)
4. Place bolt and washer thru gear and tighten. Washer should be centered on gear and not touching lock nut when bolt is tightened.
5. Use Gear Lock Nut Wrench (C-91-32329) to remove nut (bend tab out of notch in lock nut if tab washer is installed), turning tool counterclockwise. (Figure 2)
6. Remove bearing assemblies, spacer(s) and large washer from gear. Then, if upper gear has a needle bearing, press it out with mandrel and arbor press. Needle bearing is no longer required. On LEFT HAND propeller rotation units, bearing was not installed in upper gear.

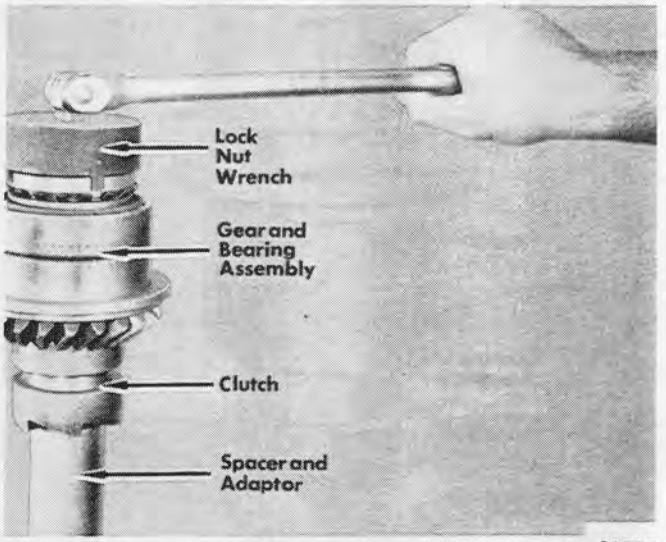


Figure 2. Removing Upper Gear Lock Nut

REASSEMBLY

1. Needle bearing is no longer required in upper gear. If old unit was equipped with this bearing, it can be removed.
2. Place bearings and spacer(s) on upper gear in following order: Large washer with chamfered side toward back of gear, tapered roller bearing with large diameter toward special washer, bearing cup over tapered roller bearing, spacer(s), bearing cup with large diameter up and tapered roller bearing in cup.

   IMPORTANT: Do not interchange tapered roller bearings and cups, as they are matched sets.

3. Place sliding clutch on spline of Wrench Adaptor (C-91-32332) and set upper gear and bearing assembly on top of sliding clutch. With early model sliding clutch, install spacer (supplied with Holding Fixture C-91-32333A1) under sliding clutch.

NOTE: Rework Wrench Adaptor Tool (C-91-32332A1) as shown in Figure 3. To complete a design change, a screw (B-10-32636) and washer (B-12-36103) are required.

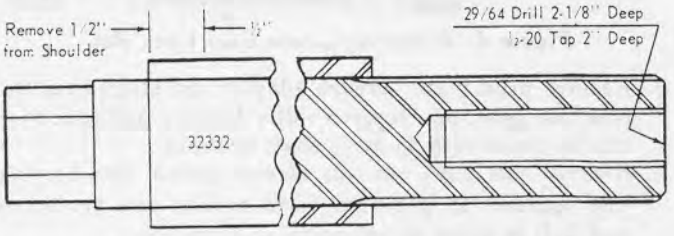


Figure 3. Reworking Wrench Adaptor (C-91-32332)

NOTE: Shimming upper gear and bearing assembly is performed after lower gear and bearing assembly removal, following.

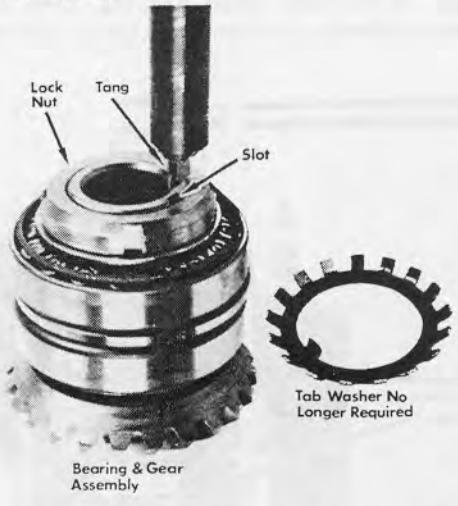


Figure 4. Swaging Upper Gear Lock Nut

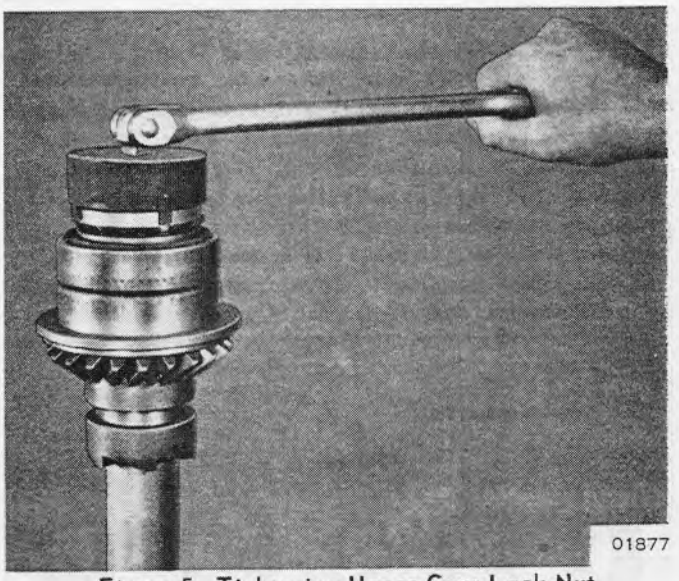


Figure 5. Tightening Upper Gear Lock Nut

4. Place retaining bolt and washer down thru gear securing tool.
5. Place lock nut on gear, chamfered side up, and torque to 150 ft. lbs. (20.7mkg), then swage lock nut with a sharp blow, using tool C-91-53122. (Figure 4) OR, place tab washer and lock nut, chamfered side down, on gear. Torque nut to 150 ft. lbs. (20.7mkg). Line up tab with a notch in lock nut, then bend lock tab into notch. (Figure 5)
6. Support top cover with Holding Fixture (C-91-32333A1), pressing upper gear and bearing assembly into cover until bearings bottom in cover. (Figure 6)

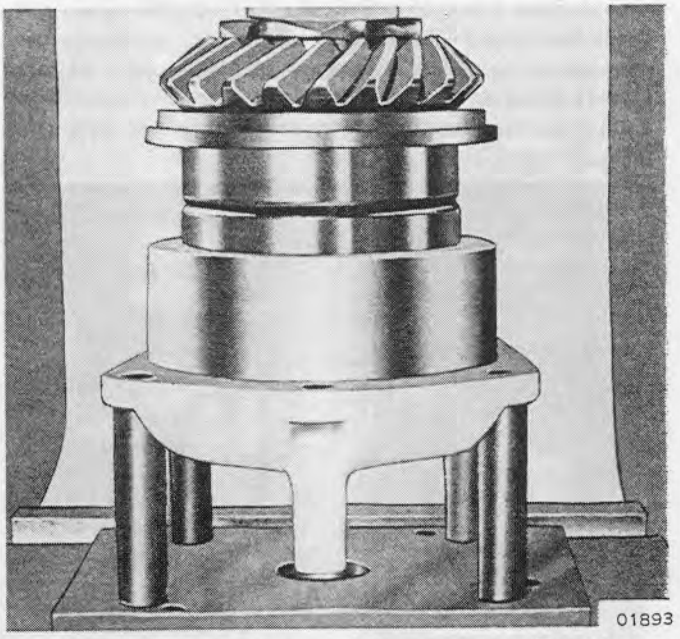


Figure 6. Pressing Gear and Bearings into Top Cover

LOWER GEAR and BEARING ASSEMBLY REMOVAL

NOTE: When removing tapered roller bearings, bearing cups and spacers from lower gear and drive shaft housing, they must be kept in a set as shown in Figure 1. If it is necessary to install new bearings on the lower gear, a complete bearing set, consisting of 2 tapered roller bearings with matching cups and spacer(s) must be installed.
Rotate gear until lock tab is in position where it can be bent out of notch with a long punch or screwdriver, if tab washer is installed.

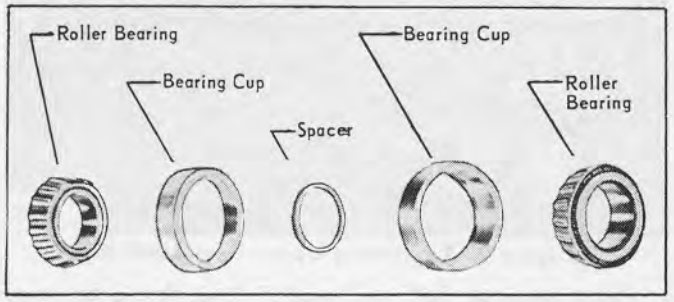


Figure 1. Bearing Set

1. Set sliding clutch on top of gear so that lugs on clutch engage lugs on gear.
2. Set splined end of Wrench Adaptor (C-91-32332A1) into center of sliding clutch and place bolt and washer thru gear from bottom of drive shaft housing and tighten into wrench adaptor. Washer should be centered on gear and not touching lock nut when bolt is tightened.
3. Place Top Cover Holding Fixture (C-91-32333A1) over adaptor and secure to drive shaft housing.
4. Hold Gear Lock Nut Wrench (C-91-32329) with drive flex handle and 6" extension (Figure 2) on later units, otherwise it will be necessary to place edge of large screwdriver in one notch of lock nut and rotate gear until screwdriver touches gear housing and acts as a jam. (Figure 3)

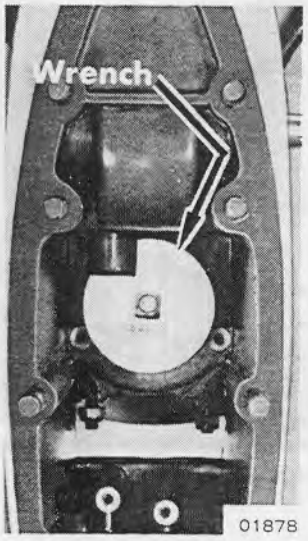


Figure 2. Gear Lock Nut Wrench in Position over Lock Nut

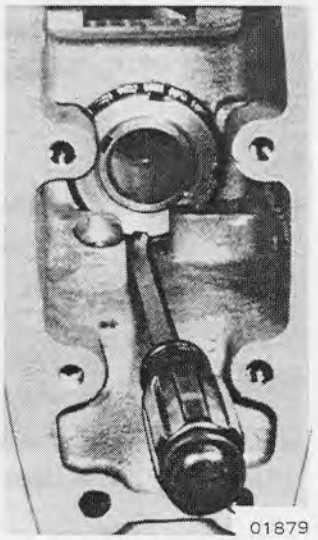


Figure 3. Holding Lower Gear Lock Nut on Early Model Units

5. Loosen lock nut by turning adaptor counterclockwise. (Figure 4) Remove retaining bolt and washer and continue to remove lock nut.

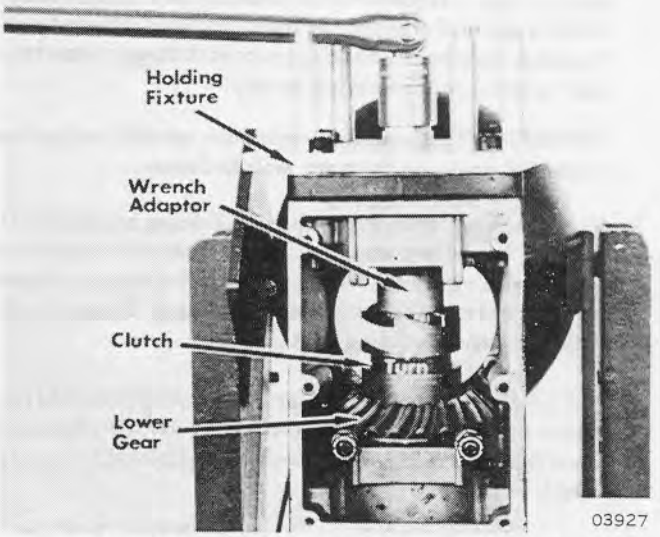


Figure 4. Removing Lower Gear Lock Nut

6. Remove pilot plate, wrench adaptor and sliding clutch. Now the gear, one tapered roller bearing and spacer(s) can be removed from drive shaft housing.
7. Remove jam nuts and set screws which lock bearing cup retainer in position. Some models use set screw and ball in place of set screw and jam nut.
8. Place Retainer Driver (C-91-35545) with lugs in notches in retainer. Place drive end of Wrench Adaptor (C-91-32332A1) into driver with spacer supplied with tool assembly.
9. Set Holding Fixture (C-91-32333A3) over adaptor and fasten it to drive shaft housing, then turn adaptor counterclockwise until retainer can be removed. (Figure 5)

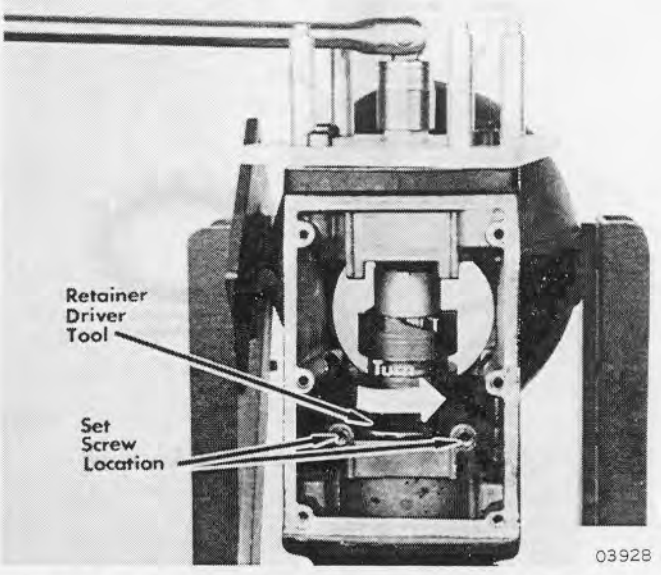


Figure 5. Removing Lower Gear Bearing Cup Retainer

10. Place Bearing Puller Head (C-91-36379) -- using Bearing Removal and Installation Kit C-91-31229A4 -- to remove bearing, cups and shims from housing. (Figure 6)

This completes disassembly of drive shaft housing. All parts now should be washed in cleaning solvent and inspected for wear, replacing parts which are worn or damaged.

NOTE: Reassembly of lower gear and bearing assembly follows "Shimming Upper Gear and Bearing", following.

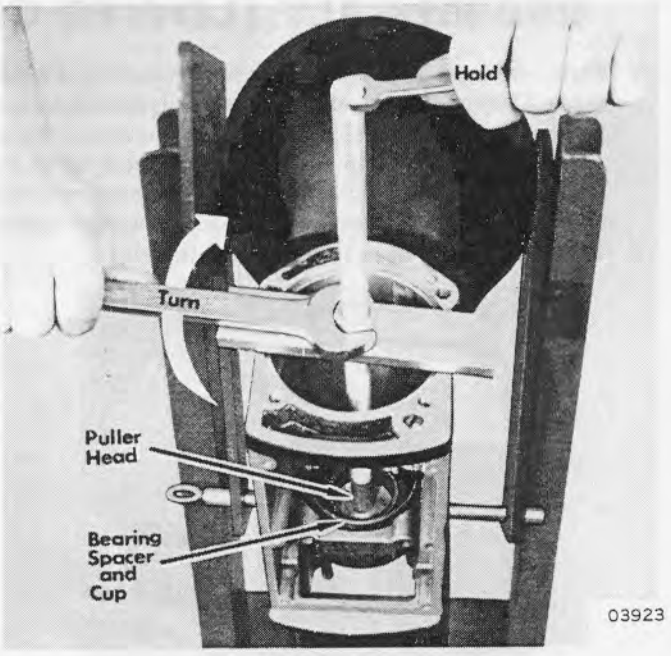


Figure 6. Removing Bearing Spacers and Cups

SHIMMING UPPER GEAR and BEARING ASSEMBLY in DRIVE HOUSING

NOTE: MerCruiser II 1.78:1 drive must follow this procedure. The C-91-52001 Shimming Tool will not fit if the lower gear is installed first. Shimming Tool C-91-32335 is used for the 1.33:1 drive; C-91-52001 may be used for either 1.33:1 or 1.78:1 drives.

1. Place Shimming Tool C-91-52001 or C-91-32335 in housing thru pinion retainer opening with flat surface clearing upper gear. Replace shims in drive housing and install top cover assembly in drive shaft housing without rubber "O" ring and cover shims. Tighten cover but do not torque.
2. Rotate tool, then measure gap between rounded tool surface and flat surface on gear tooth with feeler gauge. (Figure 7)
   a. Gap between tool and gear with 35° spiral angle gears (early 1.33:1 drives) - .032" (.813mm).
   b. Gap between tool and gear with 20° spiral angle gears (later 1.33:1 and all 1.78:1 drives) - .025" (.635mm).

If gap between tool and gear tooth is greater than specified, shims must be removed from drive shaft cover equal in thickness to amount of feeler gauge reading over specified size. If gap is less than specified, shims equal in thickness to amount of feeler gauge reading less than specified size must be placed in drive shaft housing.

3. After determining correct shim thickness, measure gap between top cover and drive shaft housing with a feeler gauge.

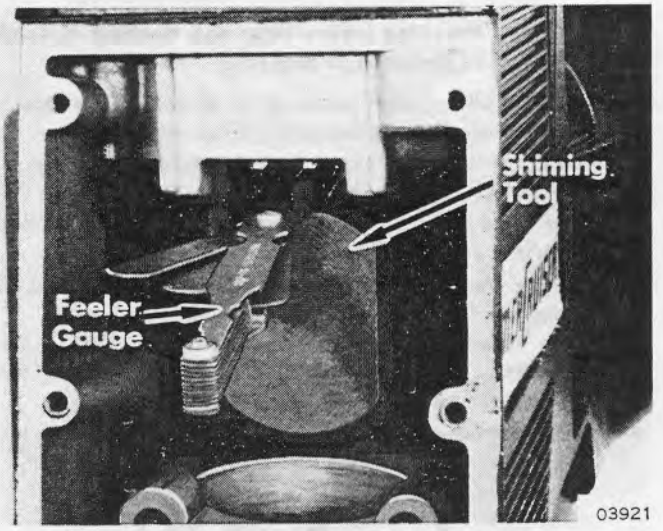


Figure 7. Measuring Gap with Feeler Gauge - 1.33:1 Upper Gear

4. Remove cover from gear housing and place shims (.002" [.051mm] less in thickness than feeler gauge) on cover along with rubber "O" ring, then install cover and torque to 30 ft. lbs. (4.14mkg).
5. Recheck gap between shimming tool and flat surface of gear tooth to make certain that correct gap still exists.
6. When shimming is correct, remove top cover assembly from drive shaft housing and place aside. Be careful not to damage or lose shims.

REASSEMBLY (LOWER GEAR and BEARING ASSEMBLY)

1. Place bearing assemblies on lower gear in following order: Tapered roller bearing with large diameter of bearing toward gear, bearing cup on roller bearing, spacer(s), bearing cup with large diameter up and roller bearing in cup. ON LEFT HAND propeller rotation unit, the lower gear needle bearing is no longer required.
2. Thread lock nut on gear and finger-tighten.

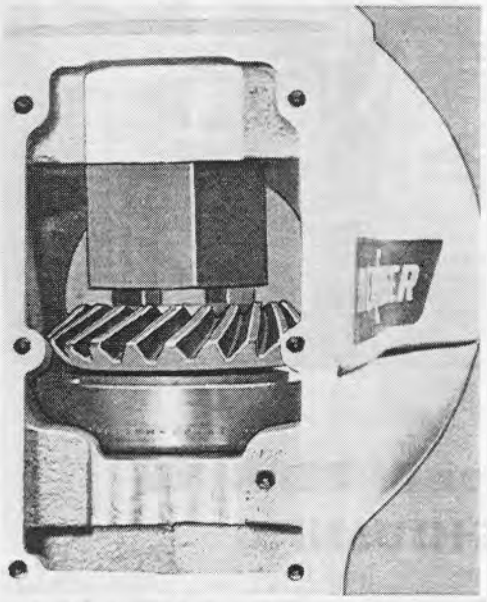


Figure 8. Pressing Lower Gear and Bearing Assembly in Drive Shaft Housing

3. Replace shims and press gear and bearing assembly into housing until it bottoms. (Figure 8)
   NOTE: If arbor press is not available, bearing and gear assembly can be installed with Bearing Puller Head (C-91-36379) and Bearing Removal and Installation Kit (C-91-31229A4).
4. Remove lock nut from gear and lift gear, tapered roller bearing and spacers out of housing.
5. Place bearing retainer with Retainer Driver (C-91-35545) and Wrench Adaptor (C-91-32332A1) into driver with spacer supplied with tool assembly.

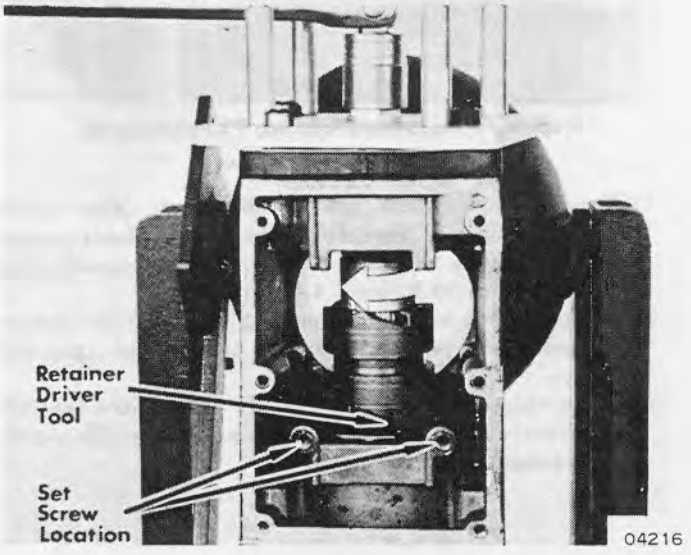


Figure 9. Installing Bearing Retainer

6. Set Holding Fixture (C-91-32333A1) over wrench adaptor to act as a pilot and fasten it to drive shaft housing, then tighten retainer clockwise and torque to 200 lbs. (27.6mkg). (Figure 9)
7. Remove pilot plate, wrench and retainer driver from housing.
   NOTE: Mark tooth on lower gear for 1.33:1 left hand drives with machinist's blueing to aid in matching gear teeth when installing pinion gear.
8. Place tapered roller bearing and spacer(s) on lower gear and set assembly in bearing cup inside housing.
9. Place lock nut on gear with chamfer up, if tab washer is not used, or, if tab washer is installed, place it and gear lock nut (chamfer down) on gear, turning gear clockwise.

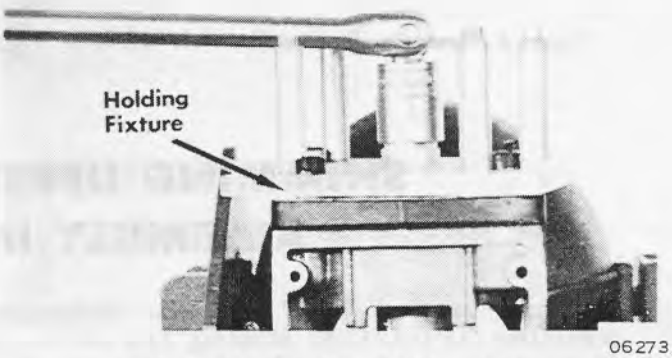


Figure 10. Installing Holding Fixture

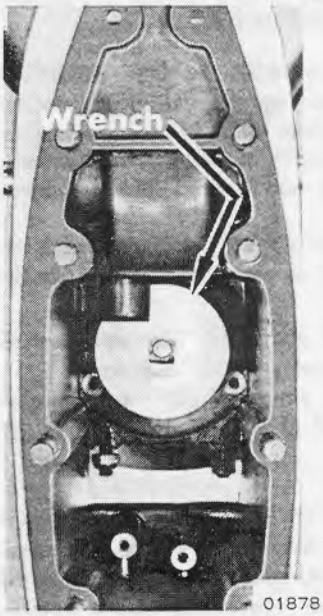


Figure 11. Gear Lock Nut Wrench in Position over Lock Nut

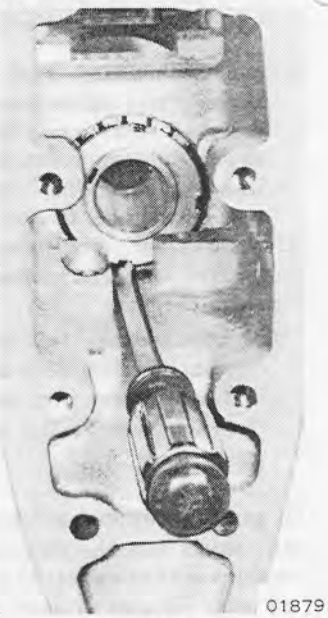


Figure 12. Holding Lower Gear Lock Nut on Early Model Drives

10. Set sliding clutch on gear so that teeth on clutch engage teeth on gear.
11. Use Wrench Adaptor (C-91-32332A1) (Figure 11) inclu and Holding Fixture (C-91-32333A1) over wrench adaptor, then tighten holding fixture to drive shaft housing. (Figure 10)

12. Place retaining bolt and washer thru gear and tighten into wrench adaptor. Washer should be centered on gear and not touching lock nut when bolt is tightened.
13. Use Gear Lock Nut Wrench (C-91-32329) to hold gear lock nut. (Figure 11) Torque to 150 ft. lbs. (20.7mkg). (Figure 13) Check shimming lower gear and bearing assembly, following, if shims were lost or if new gears or bearing assemblies were installed. If not, swage lock nut with tool C-91-53122; or, line up lock tab with notch in lock nut and bend into position. *NOTE: On early style units, it will be necessary to place edge of large screwdriver in one notch of lock nut and rotate gear until screwdriver touches gear housing and acts as a jam. (Figure 12)*

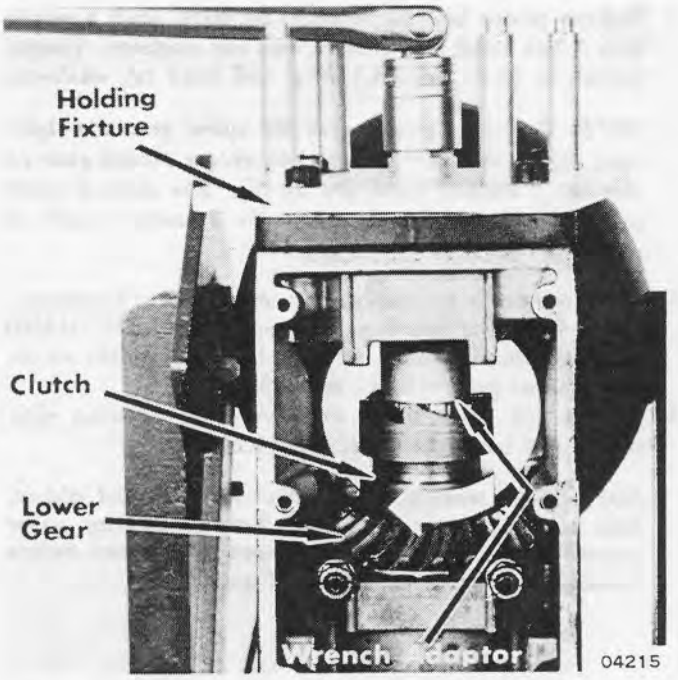


Figure 13. Torquing Lower Gear Lock Nut

SHIMMING LOWER GEAR and BEARING ASSEMBLY

1. Place Shimming Tool (C-91-52001 or C-91-32335) in drive shaft housing thru pinion retainer opening with flat surface clearing lower gear.
2. Rotate tool, then measure gap between rounded tool surface and flat surface on gear tooth with feeler gauge. (Figure 14)
   a. Gap between tool and gear with 35° spiral angle gears (early 1.33:1 drives) - .032" (.813mm).
   b. Gap between tool and gear with 20° spiral angle gears (later 1.33:1 and all 1.78:1 drives) - .025" (.635mm).

If gap between tool and gear tooth is greater than specified, shims must be added under bottom bearing cup equal in thickness to amount of feeler gauge reading over specified size. If gap is less than specified, shims equal in thickness to amount of feeler gauge reading less than specified size must be removed from under bottom bearing cup.

3. When making any change in shim thickness, gear and bearings must be reinstalled in housing and gap rechecked. Remove shimming tool and bend lock tab into notch or swage lock nut with tool C-91-53122.
4. Screw retainer locking set screws into housing and lock with jam nuts; or, on early models, replace locking balls and set screws.

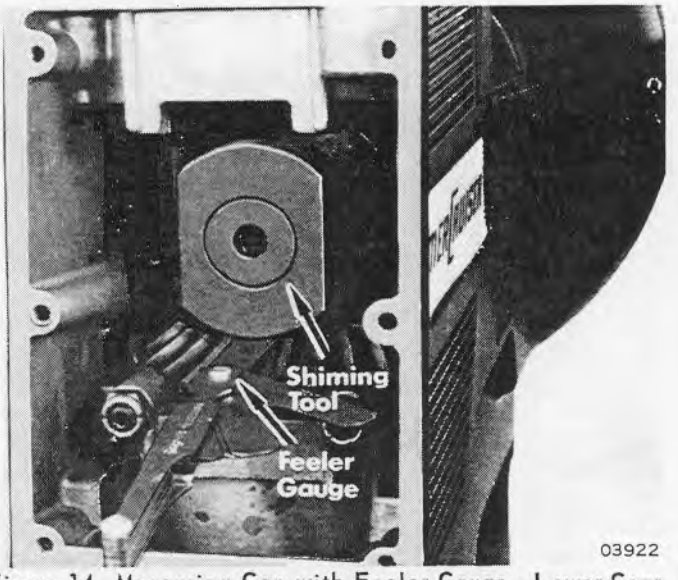


Figure 14. Measuring Gap with Feeler Gauge - Lower Gear

REASSEMBLING PINION GEAR and UPPER GEAR ASSEMBLY after SHIMMING LOWER GEAR

NOTE: On 1.33:1 drive, rotate lower gear so that marked tooth on lower gear meshes between 2 marked teeth on pinion. If unit is right hand rotation and has 20° spiral angle teeth, lower gear will not be marked, as only upper and pinion gears are marked. If unit is left hand rotation and has 20° spiral angle gear teeth, only the lower gear will be marked. All 35° spiral angle gears have forward, reverse and pinion gears marked and must be meshed according to markings. Drive gears for 1.78:1 model are not marked and do not require marking for installation.

1. Slide pinion gear and universal joint assembly with shims and "O" ring, as removed after shimming, into drive shaft housing.

2. Tighten pinion bearing retainer to drive shaft housing with 8 hex head cap screws and tab washers. Torque screws to 30 ft. lbs. (4.14mkg) and bend tab washers.

   NOTE: On 1.33:1 drives with 35° spiral gear and right hand drives with 20° spiral gear, rotate pinion gear so that the 2 marked teeth are on top. The marked tooth on upper gear meshes between the 2 marked teeth on pinion.

3. Place top cover assembly, as removed after shimming, into drive shaft housing. Remember, on LEFT HAND propeller rotation unit, if unit has 20° spiral angle gears, upper gear will not be marked.
4. Tighten top cover down to drive shaft housing with screws and torque to 30 ft. lbs. (4.14mkg).

   NOTE: Late models, Serial No. 1602186 and above, have oil passage in drive shaft housing and top cover assembly. Be sure that passages are clean before installing top cover assembly. (Figure 15)

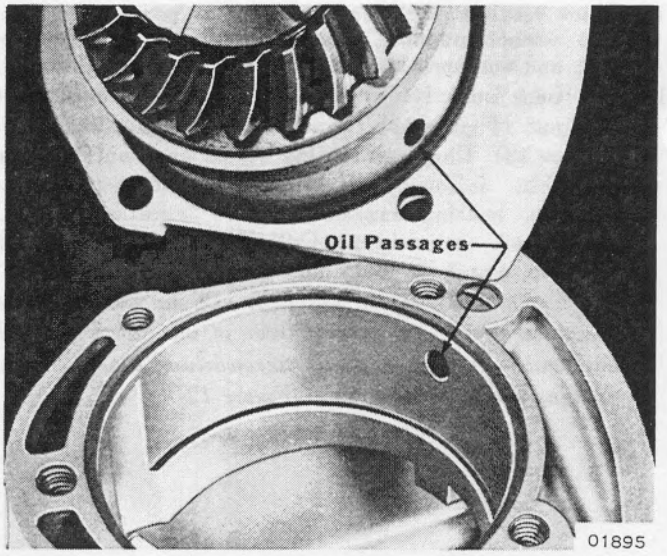


Figure 15. Oil Passages

SHIFT CABLE - OUTER HOUSING

INSTALLATION

1. Place gear rack in rack guide so that sector gear and gear rack mesh tooth-for-tooth. End of rack, which is tapped for set screw, is directed to rear of housing.
2. Place rack guide assembly, with rack installed, into drive shaft housing while sliding gear rack over core wire support.
3. Place the 4 hex head cap screws and tab washers thru rack guide. On 1.33:1 drives, do not tighten at this time. On 1.78:1 drives, tighten screws and bend tab washers to lock screws.
4. Slide inner core wire thru gear rack and outer cable. Tighten screw securely, then back off approximately ¼-turn. The screw must be loose enough to permit cable to turn freely, but tight enough to minimize end play between cable and cable slide. Place safety wire thru set screw and secure wire to gear rack so that it does not interfere with movement of rack.
5. Place cable end insert over inner core wire and thread into cable end. Tighten jam nut and place cable end guide over inner wire, snug one set screw, then tighten the other set screw securely.
6. Place sliding clutch between upper and lower gear so that ramp type teeth on clutch will mesh with forward gear. Late model sliding clutch has ramp type teeth on both ends and can move either way.

IMPORTANT: Follow "Joining Gear and Drive Shaft Housings" instructions, following, as next step on 1.78:1 drives.

SHIFT CABLE INNER CORE WIRE

REMOVAL

Before removing gear housing, it is recommended that gear lubricant (approximately 5¾ qts. [5.44 liters]) be drained by removing drain plug on bottom of gear housing and filler plug in center of rear cover.

NOTE: The 1.33:1 drive unit may be rotated 180° to ease gear housing removal.

1. Remove screw and nuts which secure cable end guide to inner transom plate. Remove shift cable end guide from inner core wire by loosening the 2 square head set screws and pulling guide away from cable. Loosen cable end insert jam nut and back insert out of cable. Remove burrs made by set screws on core wire with a file so that inner lining of cable will not be damaged when wire is drawn out.
2. Remove inner core wire from shift cable by breaking safety wire and removing set screw in end of gear rack. Push inner wire out of gear rack from opposite end of cable until wire can be gripped on rack end and drawn out.

CAUTION: If core wire has been broken, be careful that a piece of wire or small washer, which is a-round wire, does not drop out of rack and into drive shaft housing (the drive may require disassembly to remove wire).

REASSEMBLY

1. Round off end (without cylinder attached) of a new core wire with fine emery cloth to prevent damaging inner lining of cable when wire is inserted.
2. Lubricate inner core wire while sliding rounded end of wire thru gear rack and outer cable until core wire is able to be gripped at opposite end. Pull core wire until cylinder bottoms on shoulder inside gear rack.
3. Thread set screw into gear rack and tighten securely. Loosen ¼-turn and place new safety wire thru screw and wrap wire around rack tang. Twist wire tightly and cut off excess.
4. See "Joining Gear Housing to Drive Shaft Housing", then complete the following.
5. Slide end insert over core wire and thread into cable. Tighten insert and jam nut securely.
6. Grasp exposed end of core wire and push in while rotating propeller shaft until full clutch engagement is attained.

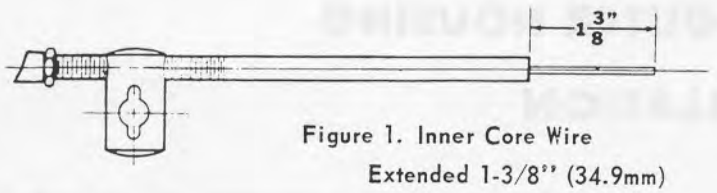


Figure 1. Inner Core Wire Extended 1-3/8" (34.9mm)

7. Measure 1-3/8" (35mm) from end of cable guide insert and cut off excess core wire at this point. (Figure 1)
8. Fasten cable end guide to core wire in anchor by snuging one set screw, then tightening the other.
9. With cable end guide installed and unit in full reverse gear (full forward gear engagement on right hand propeller rotation units), the distance from centerline of brass barrel to centerline of cable end guide mounting hole must be exactly* 6¼" (158.7mm). (Figure 2) Readjust brass barrel to achieve this dimension.

**MerCruiser II 1.78:1 drives, which have rear of engine mounted to inner transom plate, require the distance from centerline of brass barrel to centerline of cable end guide. Mounting hole must be exactly 5-7/8" (14.92cm).*

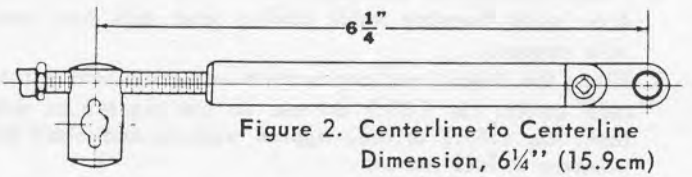


Figure 2. Centerline to Centerline Dimension, 6¼" (15.9cm)

SHIFT FORK - 1.33:1 DRIVES

INSTALLATION

STERN DRIVE SERIAL NO. 1602185 and BELOW

1. Place shift fork in position so that fingers on fork are in grooves in sliding clutch.
2. Place machine screw thru fork and link and tighten nut. On LEFT HAND propeller rotation unit, screw passes thru fork, link and spring.

STERN DRIVE SERIAL NO. 1602186 and ABOVE

1. Place shift fork in position so that fingers on fork are in grooves in sliding clutch.
2. Place screw thru fork and adaptor body assembly and secure with elastic stop nut. (Figure 3)

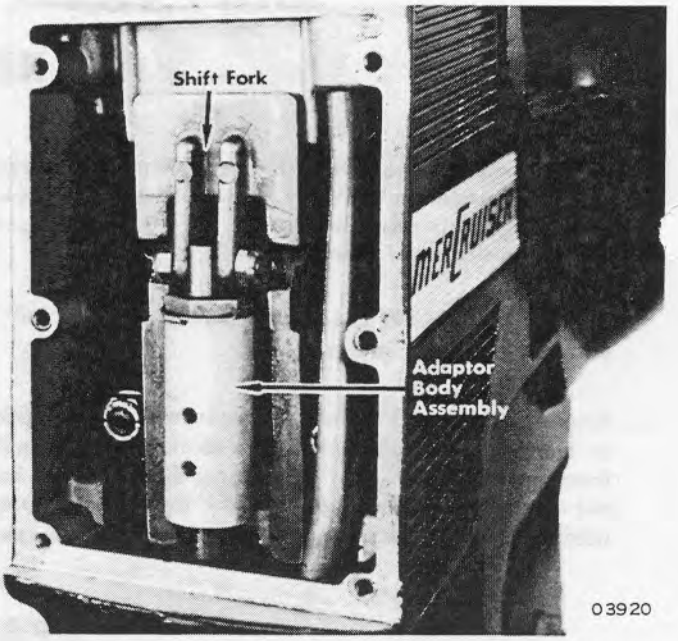


Figure 3. Fork Secured to Adaptor Body Assembly

REVERSE LOCK CAM ASSEMBLY - 1.33:1 DRIVES

INSTALLATION and ADJUSTMENT

RIGHT HAND ROTATION UNITS

1. Push in on cable end guide to engage sliding clutch into forward (upper) gear. Turn on universal joint shaft to insure complete engagement of sliding clutch to gear.

   NOTE: It will be necessary to hold shifter fork and sliding clutch in while shifting to insure complete engagement.

2. With unit engaged into forward gear position, place reverse lock gear in gear rack so that gear meshes with reverse lock gear on splined shaft.
3. While holding reverse lock gear in rack guide, slide reverse lock cam and shaft assembly thru oil seal in front section of drive shaft housing. Place flat washer on cam shaft inside drive shaft housing and continue to slide shaft thru rack guide.

NOTE: On units with Serial No. 1602186 and above, washer C-12-29395 must be installed on shaft between cam and drive shaft housing.

4. Before engaging shaft into gear, turn cam and shaft so that cam is in position shown in Figure 4 or 5.

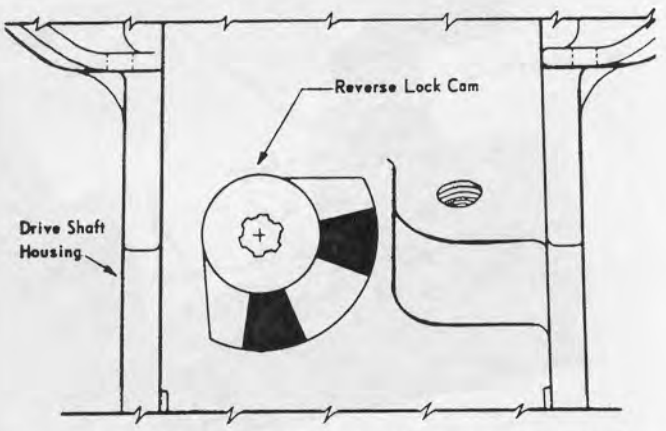


Figure 4. Position of Cam, RH Propeller Rotation Units, Serial No. 1602185 and Below

5. After inserting camshaft in gear, check that cam is in position as shown in Figure 4 or 5 and that sliding clutch is fully engaged in forward (upper) gear. If cam is not in position, slide cam and shaft assembly up and out of reverse lock gear and advance gear one tooth at a time until shaft can be inserted in gear so that cam is in correct position. If cam is not positioned correctly, reverse lock hooks will not function properly.
6. Replace cotter pin thru cam shaft so that washer is between cotter pin and surface of drive shaft housing.
7. Tighten the 4 screws, which previously were installed in the rack guide, and bend tab washers to lock screws.

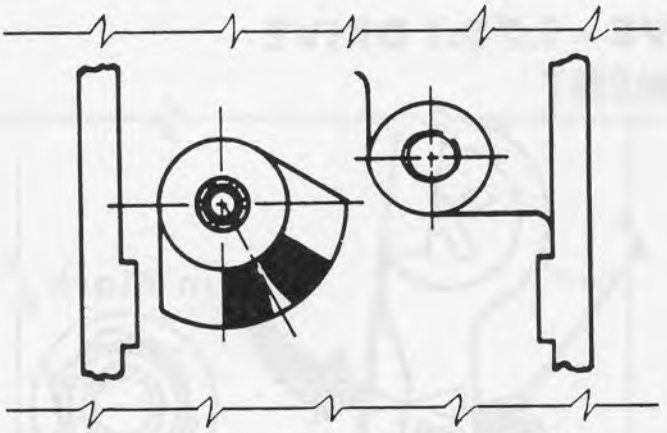


Figure 5. Position of Cam, RH Propeller Rotation Units, Serial No. 1602186 and Above

LEFT HAND ROTATION UNITS

1. Pull out on cable end guide to engage sliding clutch into forward (lower) gear. Turn on universal joint shaft to insure complete engagement of sliding clutch to gear.

   NOTE: It will be necessary to hold shifter fork and sliding clutch in while shifting to insure complete engagement.

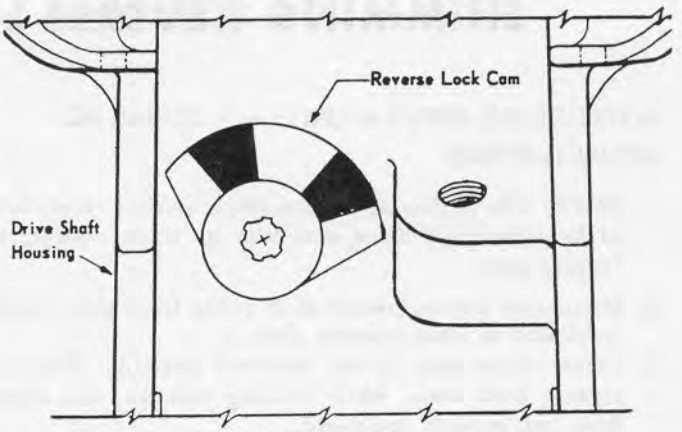


Figure 6. Position of Cam, LH Propeller Rotation Units, Serial No. 1602185 and Below

2. With unit engaged into forward gear position, place reverse lock gear in rack guide so that gear meshes with reverse lock gear on splined shaft.
3. While holding reverse lock gear in rack guide, slide reverse lock cam and shaft assembly thru oil seal in front section of drive shaft housing. Place flat washer on cam shaft inside drive shaft housing and continue to slide shaft thru rack guide.

   NOTE: On units with Serial No. 1602186 and above, washer C-12-29395 must be installed on shaft between cam shaft housing.

4. Turn cam and shaft so that cam is in position as shown in Figure 6 or 7.
5. After inserting cam shaft in gear, check that cam is in position as shown in Figure 6 or 7 and that sliding clutch is fully engaged in forward (lower) gear. If cam is not in position, slide cam and shaft assembly up and out of reverse lock gear and advance gear one tooth at a time until shaft can be inserted into gear, so that cam is in correct position. If cam is not positioned correctly, reverse lock hooks will not function properly.
6. Replace cotter pin thru cam shaft so that washer is between cotter pin and surface of drive shaft housing.
7. Tighten the 4 screws, which previously were installed in rack guide, and bend tab washers to lock screws.

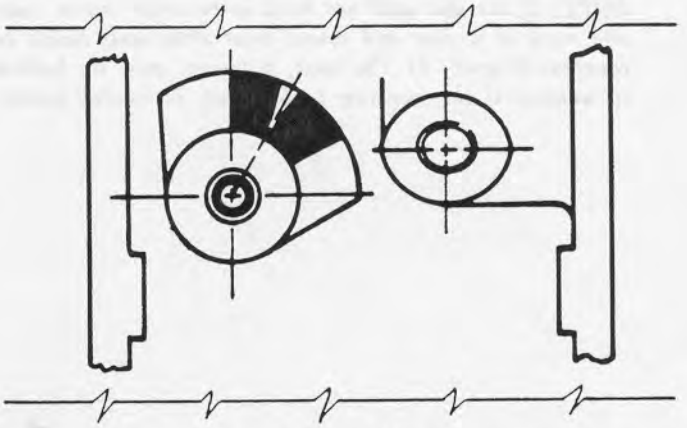


Figure 7. Position of Cam, LH Propeller Rotation Units, Serial No. 1602186 and Above

SHIMMING REVERSE LOCK CAM - 1.33:1 DRIVES

INSTRUCTIONS APPLY to UNITS with SERIAL NO. 1602186 to 2278488

NOTE: The following instructions outline procedure to be followed if drive unit tilts up when shifting to reverse gear.

1. Disconnect remote control shift cable from lever which is located on inner transom plate.
2. Rotate drive unit to the inverted position. Depress reverse hook arms, while holding unit up, and allow drive unit to pivot downward.
3. Remove shock absorber and tilt pin stud.
4. Place tilt pin stud in position on drive shaft housing. (Figure 8)
5. Shift unit into neutral gear by moving shift lever on inner transom plate and, at the same time, rotate propeller shaft. Stop moving shift lever the instant the clutch and gears are free.
6. Check amount of clearance between hooks and stop by pressing down on hooks. Clearance should be 1/32" (.8mm). (Figure 8)
7. If hooks do not clear stop by 1/32" (.8mm), remove cam from shaft by loosening set screw. Place one additional washer (C-12-29395) on shaft and reinstall cam.

NOTE: On units with Serial No. 1778954 and up, the set screw has been replaced by a cotter pin thru the shaft. If it is found necessary to install a washer under the cam, a washer of equal thickness must be removed from top of cam to prevent excessive end play of cam. Likewise, if a washer is removed from under cam, a washer of equal thickness must be added to top of cam.

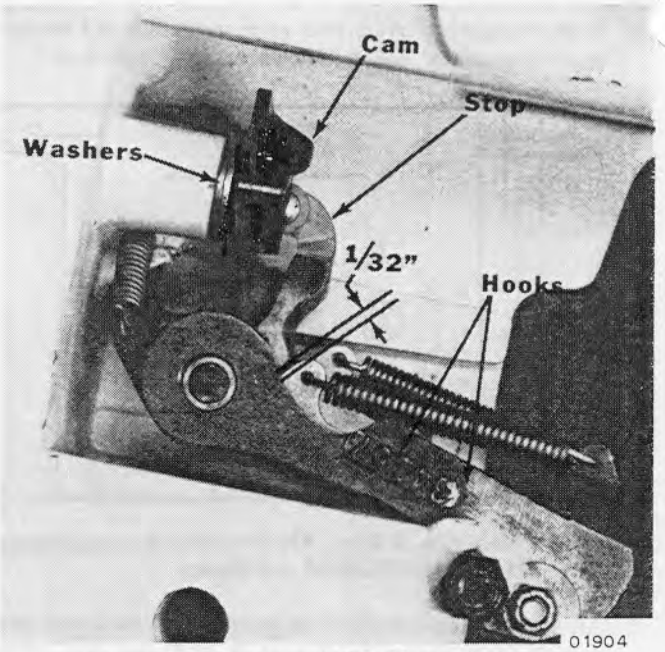


Figure 8. Position of Tilt Pin and Cam

8. Check clearance. If clearance is still not correct, add additional washers as required. Washers are available in 1/16" (1.6mm) thickness (C-12-29395) and 1/32" (.8mm) thickness (C-12-38344). It is very important that the 1/32" clearance is obtained when in neutral gear.
9. Install shock absorber and tilt pin stud, then rotate unit to operating position.
10. Check shift cable adjustments and attach shift cable to lever.

REVERSE LOCK VALVE - 1.78:1 DRIVE ADJUSTMENT

1. Loosen 2 nuts on shift lever. (Figure 9)
2. Move cam in direction required to line up raised triangular mark of cam with raised triangular mark on reverse valve cover, then tighten 2 nuts on shift lever.

NOTE: If the unit will not hold in reverse, move cam one mark at a time and retest boat until unit holds in reverse. (Figure 9) The unit, however, may be locked in neutral if the reverse lock valve is overadjusted.

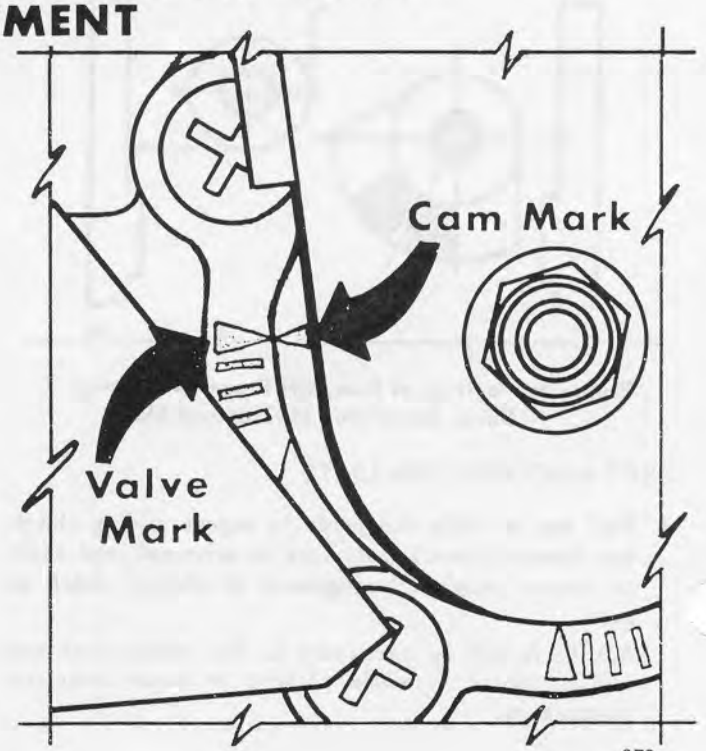


Figure 9. Reverse Lock Valve Adjustment

REVERSE LOCK HOOKS and SHOCK ABSORBER INSTALLATION

1. Place reverse lock assembly in position and slide pivot pin thru drive shaft housing and reverse lock pivot tube.

   NOTE: On late model units, Serial No. 1602186 and above, be certain that reverse lock arm tension spring is over top of drive shaft housing lug and nylon roller is on top of cam.

2. Place cotter pin thru pivot tube and shaft and bend ends.
3. Place shock absorber in position and slide lower mounting bolt thru drive shaft housing and tighten nut.
4. Drive upper shock mounting pin thru gimbal ring and shock absorber end. Stake edges of hole in gimbal ring to prevent pin from coming out.
5. Place tilt adjustment bolt thru gimbal ring. Leave nut loose enough so that bolt can rotate freely when contact is made with reverse lock hooks.
6. Raise unit up so that reverse lock hooks lock on tilt adjustment bolt.
7. Rotate unit down to normal operating position.

   NOTE: When installing Power Tilt on MerCruiser II Stern Drive Units, Serial No. 1778954 and above, remove one spring on each side of reverse hook assembly, as shown in Figure 10.

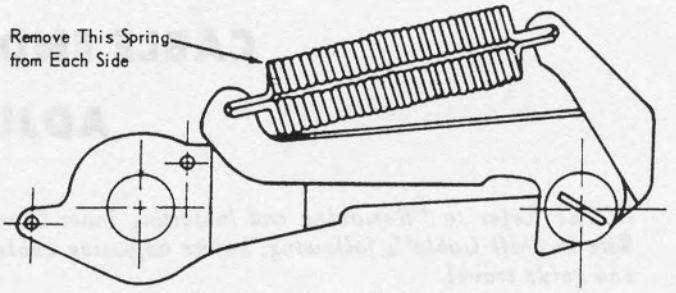


Figure 10. Reverse Hook Assembly Spring

JOINING GEAR and DRIVE SHAFT HOUSING

1. Place new gasket on drive shaft housing to gear housing mating surface.
2. Before joining housings, position trim tab allen head screw and, on late model units, install oil tube in drive shaft housing.
3. Join gear housing and drive shaft housing by inserting drive shaft thru sliding clutch.
4. With 2 housings joined, install and tighten hex lock nuts located on both sides of gear housing (4 on each side), 3 hex head cap screws located in reverse lock cavity and allen head screws located in bottom center of cavitation plate area.

   NOTE: Some models use allen head screws in place of hex lock nuts.

5. Fasten trim tab in gear housing with 5/16 allen head screw and install plastic plug in drive shaft housing.

CABLE END GUIDE TRAVEL ADJUSTMENT

NOTE: Refer to "Removing and Installing Inner Core Wire in Shift Cable", following, before adjusting cable end guide travel.

1. Place rear cover on drive shaft housing and secure with 2 screws only. It may be necessary to remove rear cover to adjust shift mechanism.
2. Shift mechanism must be adjusted so that, when sliding clutch travels from full engagement in forward gear to full engagement in reverse gear, cable end guide travels exactly 2" (51mm). Adjust and check as follows:
   a. Push in on cable end guide and, at the same time, rotate propeller shaft so that clutch fully engages gear. Place a piece of masking tape around cable insert at edge of end guide.
   b. Pull out on end guide and, at the same time, rotate propeller shaft so that clutch fully engages gear. Cable end guide must travel exactly 2" (51mm) when sliding clutch is shifted from full engagement in forward gear to full engagement in reverse gear.
   c. Turn yoke in to increase cable travel, turn yoke out to decrease cable travel. Recheck cable travel after adjusting. (Figure 1)

   NOTE: Yoke must be adjusted one full turn at a time to prevent adaptor from striking its shaft.

3. After adjustment has been completed, install new gasket on rear cover and fasten cover to drive shaft housing with 6 screws.

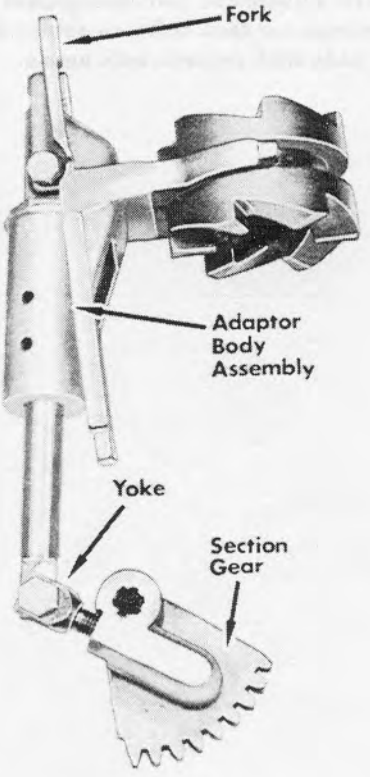


Figure 1. Yoke Attached to Cable and Sector Gear

TILT STOP SWITCH and LIMIT SWITCH

REMOVAL

1. Stern drive unit must be locked securely in normal running position.
2. Remove switch leads from terminal block located on inner transom plate.
3. Remove 2 nylon clips which hold switch to steering lever housing and to the clamp nut cover.
4. Support weight of unit with overhead hoist, using lifting eye in top cover of drive shaft housing.
5. Remove lubricaps and grease fittings located in ends of hinge pins (if applicable).
6. Remove pins which lock hinge pins in gimbal ring. Use thin punch approximately 2¼" (57mm) long.
7. Remove hinge pins with Hinge Pin Puller (C-91-36060).
8. Remove tilt adjustment bolt and slide entire unit back approximately 4" (10.2cm). This will allow sufficient clearance to remove switch.
9. Remove 2 screws which fasten switch actuating lever to gimbal ring.
10. Remove 2 screws which fasten switch retaining plate to gimbal ring.
11. Remove nylon clip which fastens switch lead to gimbal housing.
12. Remove 2 screws which fasten switch lead retainer to gimbal housing.
13. Cut switch leads and remove switch.

REASSEMBLY

1. Install new switch in gimbal housing.
2. Install spacer and retainer plate. Position retainer plate with shoulder facing up toward spacer.
3. Thread switch leads thru gimbal housing and install switch lead retainer.
4. Replace nylon clip and check switch leads carefully so that gimbal ring does not rub or chafe them.
5. Replace switch actuating lever.
6. Check bellows carefully. It must not be kinked or folded unevenly.
7. Slide entire unit into gimbal ring and align hinge pin holes.
8. Install anti-galling washer between drive shaft housing and gimbal ring. For easier installation, grease washer to hold it in place while hinge pin is being installed.
9. Install hinge pin with Hinge Pin Puller (C-91-36060).

NOTE: Lubricate hinge and retainer pins with Anti-Corrosion Grease.

10. Install other washer and hinge pin the same way.
11. Install hinge pin retaining pins.
12. Install grease fittings and lubricaps.
13. Install 2 nylon clips which secure switch lead to steering lever housing and clamp nut cover.
14. Install switch leads on terminal block.

15A. Check tilt stop circuit with continuity meter to be sure that circuit is "open" when unit is down in operating position and that circuit is "closed" when unit is tilted.

B. Check trim limit circuit with continuity meter to be sure that circuit is "closed" when unit is down in operating position and that the circuit is "open" when unit is tilted.

DRIVE CONVERSION

CONVERTING LEFT HAND ROTATION to RIGHT HAND ROTATION DRIVES

1.33:1 DRIVE, SERIAL NO. 1602186 and ABOVE

NOTE: To convert propeller rotation, cam must be repositioned and cable on inner transom plate must be repositioned. No internal changes are necessary.

1. Rotate drive unit to inverted position with hand crank.
2. Push gear housing end of drive unit toward transom. While holding drive unit in this position, press both reverse lock hook arms down by hand and allow drive unit to pivot downward.
3. Remove nut from bolt, which fastens shock absorber to drive shaft housing, and remove bolt. Pivot shock absorber up toward gimbal ring.
4. Note positions of component parts of reverse lock assembly for reference when reassembling.
5. Remove cotter pin which passes thru reverse lock pivot tube and shaft.
6. Push pivot shaft out of drive shaft housing and remove reverse lock assembly from housing. Handle assembly carefully so that it does not become disassembled.

7. Loosen set screw which fastens cam to shaft, using a 5/64" allen wrench. Continue to loosen screw until cam can be removed from shaft.
8. Hold brass barrel, located on drive unit shift cable, and push cable end guide toward brass barrel while rotating propeller shaft. Continue to push end guide toward brass barrel until it stops.

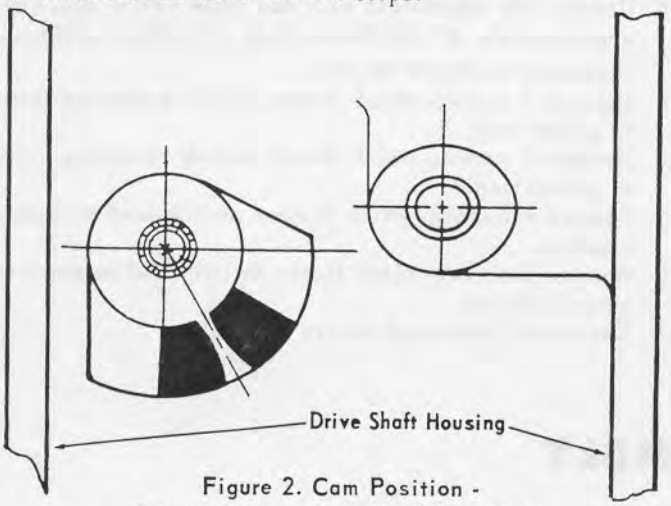


Figure 2. Cam Position - Forward Gear, Right Hand Rotation

9. Place cam on shaft in position, as shown in Figure 2, and tighten set screw securely.
10. Install reverse lock assembly, pivot shaft and cotter pin. Be sure that reverse lock arm tension spring is over top of drive shaft housing lug and nylon roller is on top of cam.
11. Install shock absorber, bolt and nut.
12. Pivot drive unit up until reverse lock hooks lock on tilt adjustment bolt.
13. Rotate drive unit down to operating position with hand crank. Continue to turn crank until it is tight and drive unit is locked in operating position.

1.78:1 DRIVE

1. Install a left hand rotation propeller of selected pitch and diameter.
2. Reposition and readjust shift cables. (Refer to "Removal-Installation-Alignment" Section II.
3. Remove link rod from upper reverse lock lever arm and reinstall onto lower arm, as shown in Figure 3.

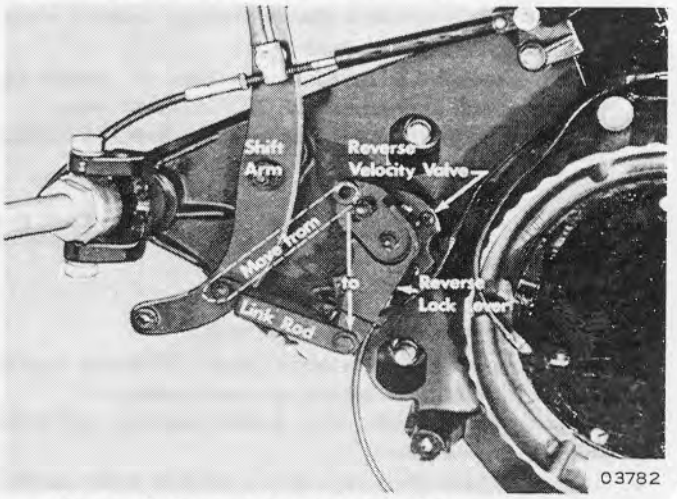


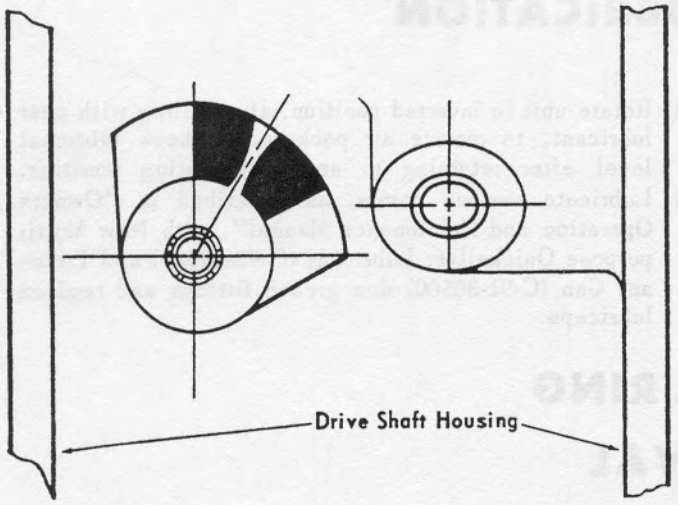
Figure 3. Converting Left Hand Rotation to Right

CONVERTING RIGHT HAND ROTATION to LEFT HAND ROTATION DRIVES

1.33:1 DRIVE, SERIAL NO. 1602186 and ABOVE

NOTE: To convert propeller rotation, cam must be repositioned and cable on inner transom plate must be repositioned. No internal changes are necessary.

1. Rotate drive unit to inverted position with hand crank.
2. Push gear housing end of drive unit toward transom. While holding drive unit in this position, press both reverse lock hook arms down by hand and allow drive unit to pivot downward.
3. Remove nut from bolt, which fastens shock absorber to drive shaft housing, and remove bolt. Pivot shock absorber up toward gimbal ring.
4. Note positions of component parts of reverse lock assembly for reference when reassembling.
5. Remove cotter pin which passes thru reverse lock pivot tube and shaft.
6. Push pivot shaft out of drive shaft housing and remove reverse lock assembly from housing. Handle assembly carefully so that it does not become disassembled.
7. Loosen set screw which fastens cam to shaft, using a 5/64" allen wrench. Continue to loosen screw until cam can be removed from shaft.
8. Hold brass barrel, located on stern drive unit shift cable, and pull cable end guide away from brass barrel while rotating propeller shaft. Continue to pull end guide away from brass barrel until it stops.
9. Place cam on shaft in position, as shown in Figure 4, and tighten set screw securely.
10. Install reverse lock assembly, pivot shaft and cotter pin. Be sure that reverse lock arm tension spring is over top of drive shaft housing lug and nylon roller is on top of cam.
11. Install shock absorber, bolt and nut.
12. Pivot drive unit up until reverse lock hooks lock on tilt adjustment bolt.



13. Rotate drive unit down to operating position with hand crank. Continue to turn crank until it is tight and drive unit is locked in operating position.

1.78:1 DRIVE

1. Install a right hand rotation propeller of selected pitch and diameter.
2. Reposition and readjust shift cables. (Refer to "Removal-Installation-Alignment" Section II.
3. Remove link rod from lower reverse lock lever arm and reinstall onto upper arm. (Figure 3)

Figure 4. Cam Position – Forward Gear, Left Hand Rotation

DRIVE UNIT LUBRICATION

1. Replace drain plug located on bottom of gear case.
2. Remove filler plug from rear cover and fill unit with Kiekhaefer SUPER-DUTY Quicksilver Gear Lubricant that is available in 25 lb. pails (C-92-52645-1). A portable lubricant gun and hose (C-91-26150) is available to fit the pail of lubricant. Capacity of unit is approximately 6 quarts (5.68 liters).
3. Install filler plug and gasket.
4. Rotate unit to inverted position, after filling with gear lubricant, to remove air pockets. Recheck lubricant level after returning to normal operating position.
5. Lubricate various points, as described in "Owners Operation and Maintenance Manual", with New Multipurpose Quicksilver Lubricant (C-92-49588) and Lubriant Gun (C-91-30500) thru grease fittings and replace lubricaps.

GIMBAL RING

REMOVAL

GIMBAL RING from GIMBAL HOUSING

1. Remove steering arm link rod bolt and nut from gimbal ring.
2. Loosen hose clamp and remove bellows from gimbal housing.
3. Remove switch actuation spring lever by removing 2 slotted head screws which fasten lever to gimbal ring.
4. Remove 2 hex head cap screws which hold switch lead cover to gimbal housing.
5. Remove 2 screws and clamps which hold switch leads to gimbal housing and steering lever housing.
6. Drive out lower swivel pin retaining pin with a long punch and remove swivel pin from gimbal ring and housing by tapping out with drift punch.
7. Remove top pivot bolt nut with 15/16 socket and tap bolt out of gimbal ring with mallet. Gimbal ring now is free and can be removed from gimbal housing.
8. Remove switch assembly from gimbal ring by removing 2 slotted head screws which hold switch retaining plate to gimbal ring. Check switch with ohmmeter by hooking one clip from meter to each switch lead. Depress switch and read meter. On 1.33:1 drives, if meter shows no resistance, tilt switch is OK. On 1.78:1 drives, if meter shows resistance, trim limit switch is OK.

GIMBAL HOUSING from STEERING LEVER HOUSING

1. Remove hose clamps from shift cable bellows and remove bellows.
2. Pull shift cable thru gimbal housing steering lever housing.
3. Break safety wire and remove six 3/4" hex head cap screws and washers which hold gimbal housing to steering lever housing. Remove steering link rod from gimbal ring if not already disconnected. Gimbal housing now is free and can be removed from steering lever housing.
4. Remove ball bearing assembly from gimbal housing by tapping lightly and evenly on outer sleeve with drift punch.

UPPER and LOWER STEERING LEVER

1. Remove steering lever housing from transom plates.
2. Remove two 9/16 hex head screws from upper and lower steering arms.
3. Remove steering shaft from steering lever housing.
4. Remove needle bearings and oil seals from housing.

This completes disassembly of gimbal ring, gimbal housing and steering lever housing assemblies. All parts now should be washed in cleaning solvent and inspected for wear, replacing those which are worn or damaged.

REASSEMBLY

1. Install new needle bearings and oil seals in steering lever housing.
2. Place steering shaft in housing and place upper and lower steering arms in shaft.
3. Place hex head screws thru arms and torque to 30 ft. lbs. (4.14mkg).
4. Bend tab on tab washer to lock screws in position.
5. Install new bearing and oil seals in gimbal housing, preceding.
6. Place new gasket and "O" ring on gimbal housing to steering lever housing mating surface.
7. Join the 2 housings and install hex head cap screws and washers.
8. Torque screws to 75 ft. lbs. (10.35mkg) and attach safety wire thru screw heads.
9. Install assembly in transom plates.
10. Install new needle bearings and oil seals in gimbal ring.
11. Install tilt stop or trim limit switch in gimbal ring.
12. Place upper pivot bolt in gimbal housing and place gimbal ring in housing. Place nut on pivot bolt and torque nut to 100 ft. lbs. (13.8mkg).
13. Install lower swivel pin and retaining pin.
14. Insert shift cable thru gimbal housing and steering lever housing. Fasten bellows to gimbal housing and shift cable with hose clamps.
15. Insert tilt switch leads thru gimbal housing and steering lever housing.
16. Fasten switch leads to gimbal housing with clamps and screws.
17. Lubricate various components with New Multipurpose Lubricant (C-92-49588) and Lubricant Gun (C-91-30500) thru grease fittings.

INSTALLING HYDRAULIC HOSES and CONNECTOR

1. Install fittings of long hydraulic hoses to center of connector with upper hose fitting bend to the left and lower hose fitting bend to the right.
2. Install connector so that upper hose has bend to the left, then tighten screws.
3. Install 4 short hydraulic hoses to connector.
4. Install trim cylinders.

NOTE: Bleeding Hydraulic System will be necessary after completing drive installation.

5. Install the 2 hydraulic hoses, that are closest to the anodic plate, to "UP" ports on trim cylinders and remaining hoses to the "DOWN" ports. (Figure 1)
6. Reinstall drive unit and connect hydraulic hoses as outlined in "Removal-Installation-Alignment" Section II.

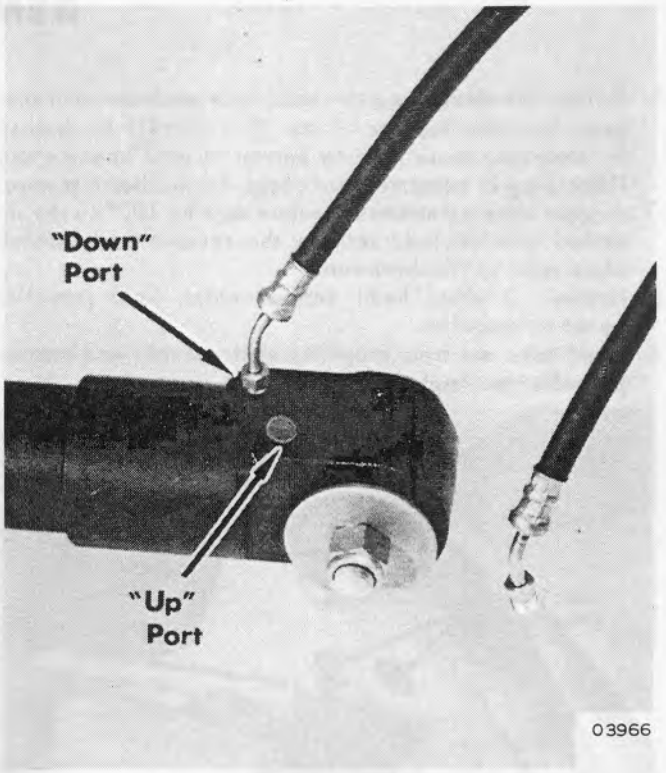


Figure 1. Hoses Installed

GIMBAL HOUSING BEARING and BEARING ADAPTORS

REMOVAL

NOTE: Gimbal housing assembly must be disassembled to remove and install gimbal housing bearing.

1. Remove gimbal housing bearing with Slide Hammer Puller (C-91-34569A1).
2. Inspect rubber mount carefully. Replace if worn or damaged.
3. Check ball bearing for roughness.

NOTE: Ball bearing is a sealed bearing. DO NOT attempt to clean or lubricate.

REASSEMBLY

After gimball housing has been disassembled and ball bearing removed, the following procedure must be followed for correct shimming of ball bearing:

NOTE: A new one-piece ball bearing (B-30-36418) supersedes ball bearing B-30-36056, bearing carrier B-36147 and retaining ring B-53-35129 which had been used on MerCruiser II, Serial No. 1602186 and above. Although the new one-piece ball bearing is installed the same as the early ball bearing and carrier assembly, it may be necessary to reshim the nylon bearing carrier adaptor.
MerCruiser II, Serial No. 1732380 and up, have the new one-piece ball bearing installed at time of production.

1. Ball bearing is sealed. Do not attempt to clean or lubricate.
2. Late style ball bearing is a one-piece unit and does not require a bearing carrier or snap ring.
3. Install nylon bearing carrier adaptor. Shims must be placed between nylon bearing carrier adaptor and gimbal housing recess so that ball bearing or bearing carrier fits very tightly in nylon adaptor. Try different size shims until ball bearing of bearing carrier can be tilted into position with a force fit. Bearing may be tapped in with a wooden dowel.
4. After installing bearing adaptor, reinstall grease seal "O" rings and adaptor.
5. Reassemble gimbal housing.

MERCRUISER II HEAVY-DUTY GEAR HOUSING

REMOVAL

1. Before disassembling the unit, it is recommended that gear lubricant (approx. 7 qts. [6.6 liters]) be drained by removing drain plug on bottom of gear housing and filler plug in center of rear cover. To facilitate removal of gear housing assembly, rotate unit up 180° to the inverted position and release the reverse locks which allow unit to tilt downward.
2. Remove 3 allen head screws which hold propeller cover to propeller.
3. Bend tabs out from propeller shaft washer and remove propeller nut (right hand thread).

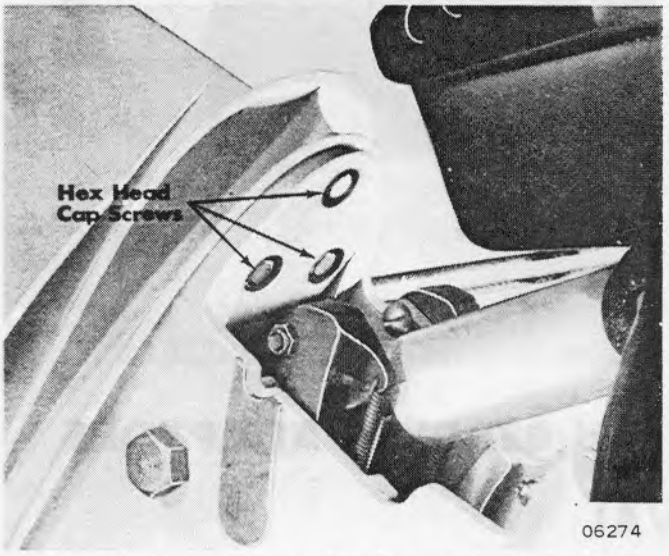


Figure 1. Screws Located in Reverse Lock Cavity

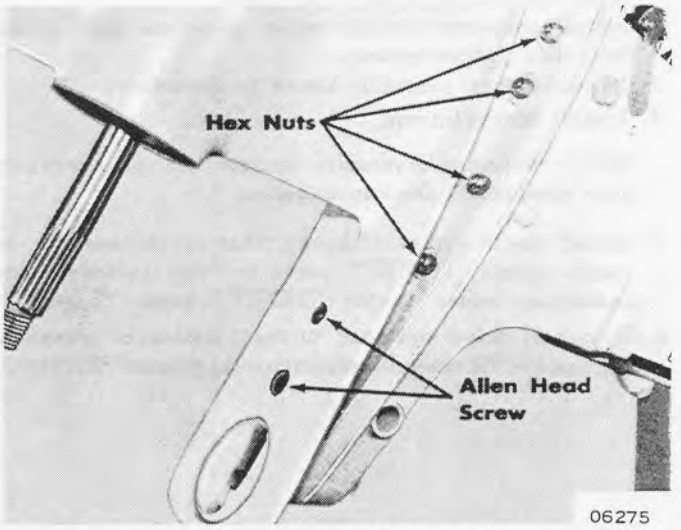


Figure 2. Removing Gear Housing from Drive Shaft Housing

4. Washer, propeller and thrust hub now can be removed from propeller shaft.
5. Remove 3 hex head cap screws in reverse lock cavity. (Figure 1)
6. Remove 8 hex nuts from both sides of gear housing (4 each side) and 2 allen head screws which are located in bottom center of cavitation plate. Some models use allen head screws instead of hex nuts. (Figure 2)
7. Gear housing assembly now can be lifted off drive shaft housing.

INSTALLATION

Installation is the reverse of removal, preceding .

PROPELLER SHAFT
REMOVAL and DISASSEMBLY

1. Mount gear housing assembly in vise between 2 blocks of soft wood to prevent marring metal surface.
2. Remove gear housing cover retainer with Gear Case Cover Tool (C-91-38457) by placing tool over propeller shaft and setting it into retainer. Turn tool counterclockwise and back retainer out of gear housing. It may be necessary to strike handle of tool with a mallet to loosen retainer before it can be turned out by hand. (Figure 3)

Figure 3. Removing Retainer from Gear Housing

3. Clamp propeller shaft in metal vise with jaw protectors and tap lightly and evenly on skeg and gear housing with mallet until gear housing cover assembly, bearing carrier assembly and propeller shaft assembly are removed from gear housing. (Figure 4)

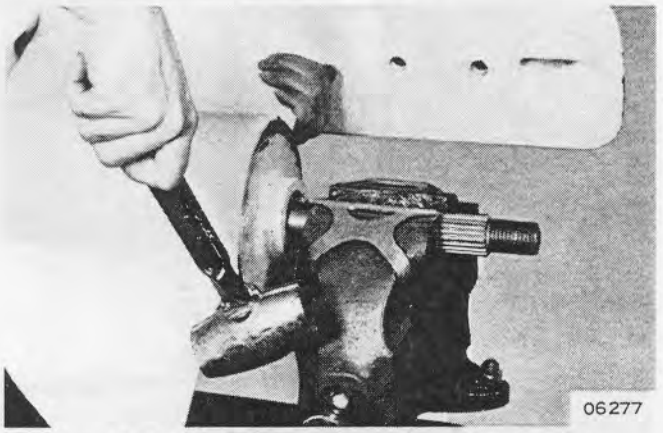


Figure 4. Removing Assemblies from Gear Housing

4. Check for shims which may adhere to bearing carrier and/or to shoulder in gear housing.
5. Slide gear housing cover and bearing carrier assemblies off propeller shaft.
6. Use Puller (C-91-39281) as a mandrel to press oil seals out of cover. (Figure 5)

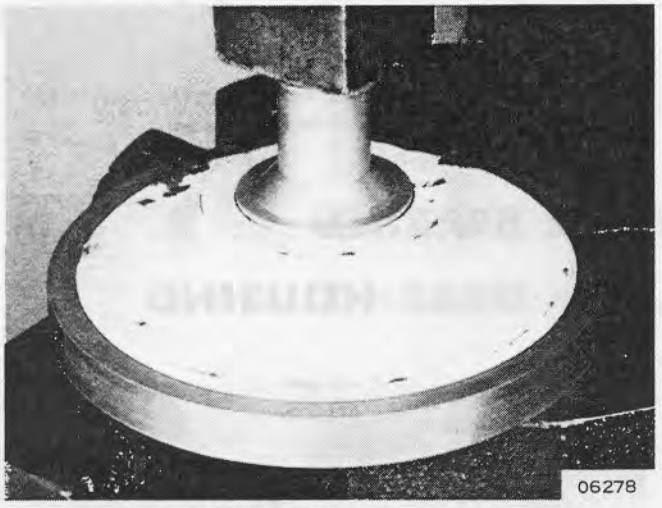


Figure 5. Pressing Oil Seals out of Cover

7. Press tapered bearing cup from carrier with any 3-7/8 dia mandrel.
8. Hold propeller shaft in vise (using vise guards to avoid marring metal surface) and remove nut from forward end of shaft (nut is right hand thread).
9. Press forward tapered roller bearing, spacer, propeller shaft gear and tapered roller bearing assembly from propeller shaft, using tool (C-91-30291A2) for support. (Figure 6)
10. Press tapered roller bearing from gear with Universal Puller Plate (C-91-37241). (Figure 7) Propeller shaft spacer may be used as press adaptor.
11. Remove tapered roller bearing cup from gear housing with Universal Slide Hammer (C-91-34569A1). (Figure 8)
12. Check for shims which may adhere to bearing cup or to bearing seat in gear housing.

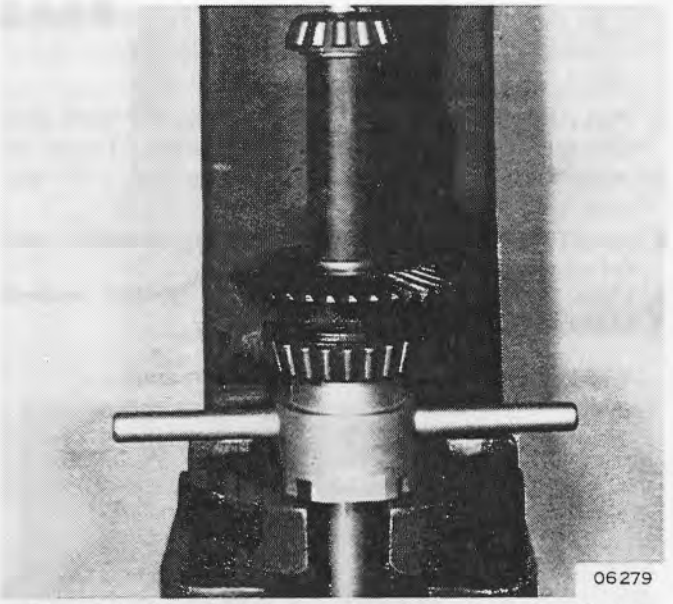


Figure 6. Pressing Components from Propeller Shaft

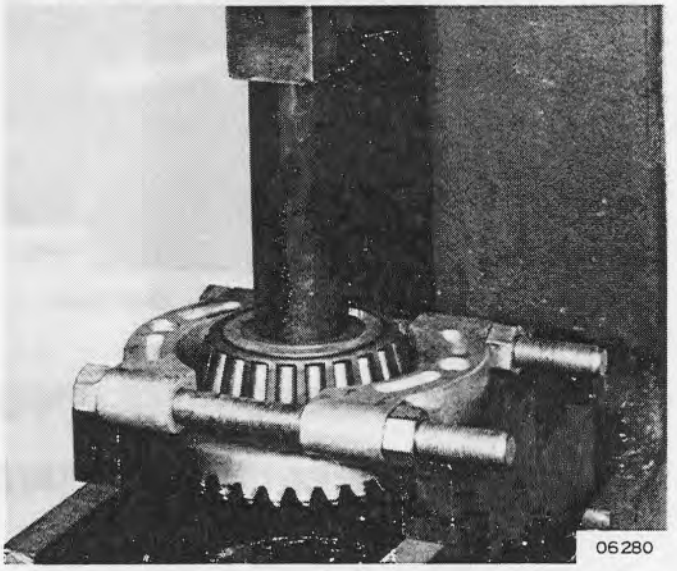


Figure 7. Pressing Tapered Roller Bearing from Gear

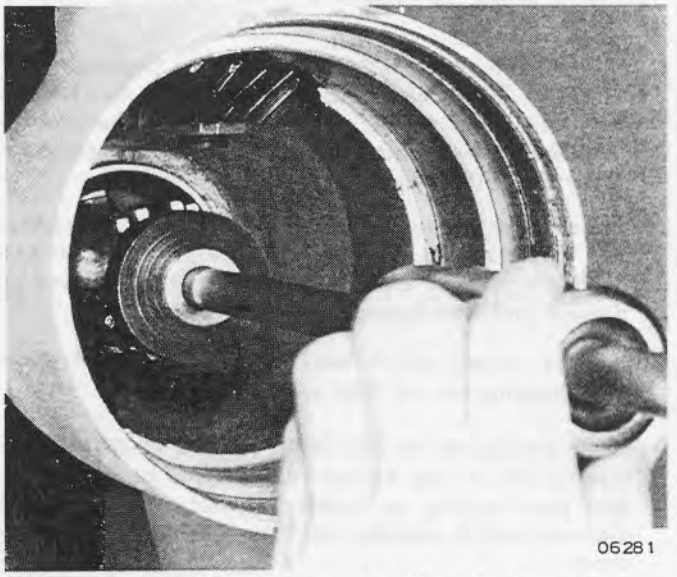


Figure 8. Removing Tapered Roller Bearing Cup

REASSEMBLY

1. Press tapered roller bearing onto propeller shaft gear with tool C-91-30291A2 to support bearing. (Figure 9)
2. Press bearing cup into bearing carrier with a 5" diameter plate as a mandrel.
3. Install propeller shaft gear and bearing assembly onto splines of propeller shaft.
4. Place spacer on shaft and install forward tapered bearing, washer and nut.

NOTE: Cupped face of washer faces bearing.

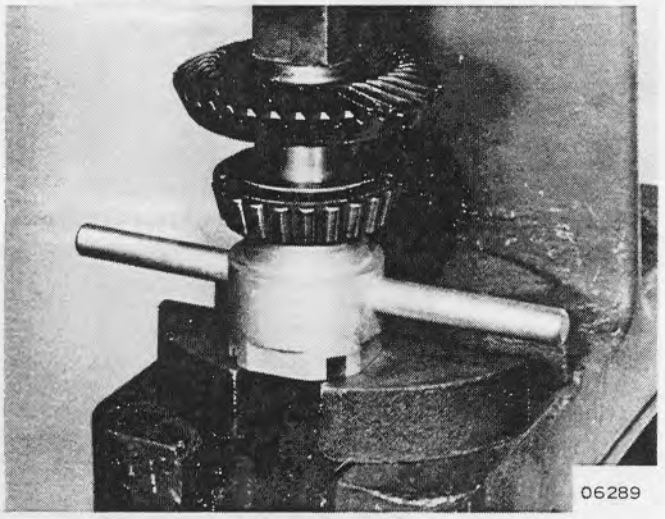


Figure 9. Pressing Bearing on Propeller Shaft Gear

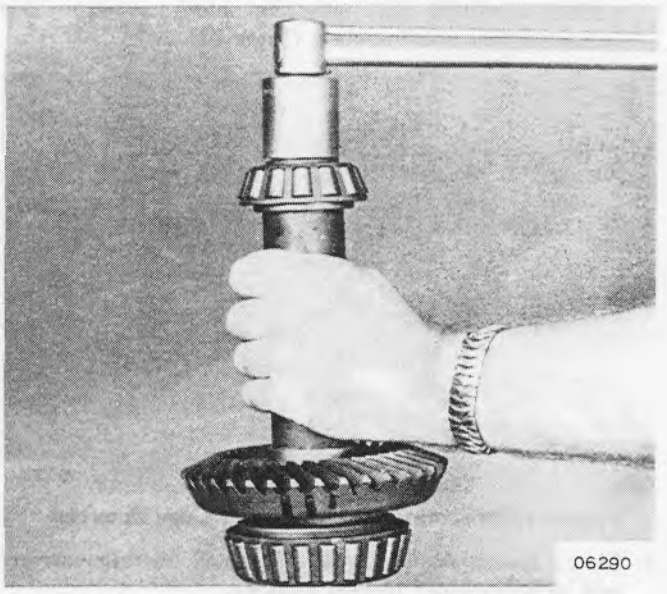


Figure 10. Torquing Nut

5. Hold propeller shaft in vise (using jaw protectors) and tighten vise securely. Torque nut to 150 ft. lbs. (20.7 mkg). (Figure 10) Hold shaft for leverage and to steady shaft.

6. Press oil seals into gear housing cover. Outer seal has lips out and inner seal has lips facing in.

REASSEMBLING NEEDLE BEARING and TAPERED BEARING CUP in GEAR HOUSING

1. Install drive shaft needle bearing by placing bearing on Puller Head (C-91-38762) with numbered side of bearing up.

2. Place bearing and puller head in gear housing cavity and pass Puller Shaft (C-91-31229) down thru bearing seat. Use box wrench to hold puller head while threading puller shaft into puller head. Tighten shaft firmly into puller head.

3. Place plate, washer and nut on puller shaft and tighten nut carefully. Puller head is designed to position bearing to correct depth in bearing recess. (Figure 11) Remove tool after bearing is seated.

4. Replace shims, which were removed originally from under bearing cup, in front of gear housing.

5. Place bearing cup on Cup Drive Tool (C-91-38761) with tapered end of cup against driver. Set cup with tool into gear housing on bearing shoulder. Place small diameter end of propeller shaft into center hole of cup driver.

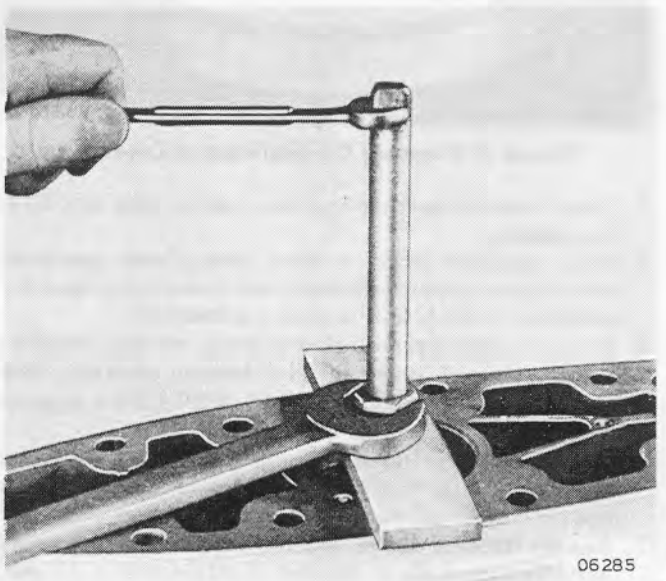


Figure 11. Installing Drive Shaft Needle Bearing

6. Place gear housing cover assembly into housing to act as a guide for holding propeller shaft straight when pressing cup into position. Drive cup into gear housing with mallet until it bottoms. (Figure 12)
7. Remove cover assembly by pulling propeller shaft out of gear housing and remove cup driver.

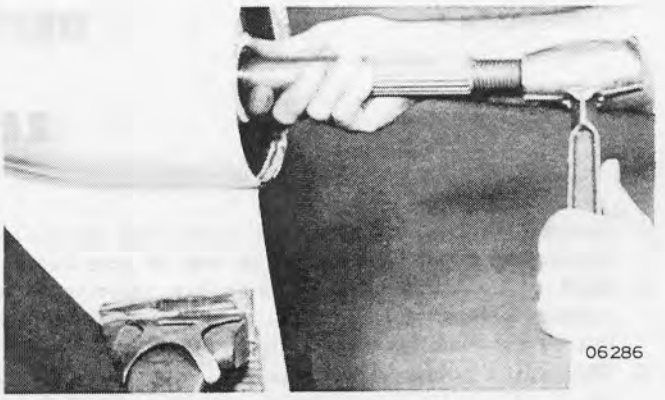


Figure 12. Driving Cup into Gear Housing

PROPELLER SHAFT ASSEMBLY, BEARING CARRIER ASSEMBLY and GEAR HOUSING COVER REASSEMBLY

1. Place complete propeller shaft assembly into gear housing.
2. Place shims, which were removed previously, from under cup carrier on shoulder in gear housing.
3. Apply a light coat of New Quicksilver Multipurpose Lubricant (C-92-49588) to outside diameter of bearing cup carrier and slide carrier into gear housing until it bottoms.

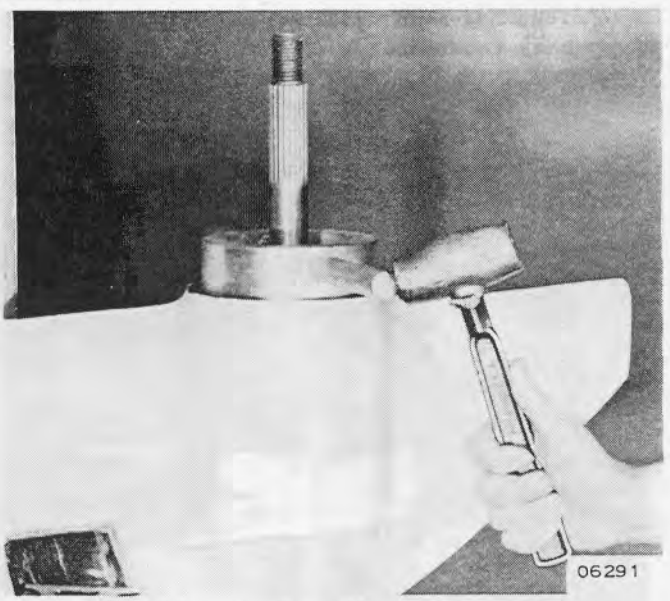


Figure 13. Tightening Gear Housing Cover Retainer

4. Install new rubber "O" ring in carrier recess.
5. Apply a light coat of New Multipurpose Lubricant to propeller shaft oil seal and to outside diameter of cover.
6. Slide cover assembly over shaft until it bottoms on bearing cup carrier in housing.
7. Place anti-galling washer in cover recess.
8. Coat retainer threads with a light film of Anti-Seize Compound (C-92-38349) and screw retainer into gear housing. Tighten retainer securely with Gear Housing Cover Tool (C-91-38457) by tapping on tool handle with mallet. (Figure 13)
9. Check propeller shaft for end play by attempting to move shaft in fore and aft direction. If propeller shaft can be moved in either direction, remove shims from under bearing cup carrier. If propeller shaft has no end play and does not rotate freely, shims must be added under bearing cup carrier. Propeller shaft should have no end play and should rotate freely in both directions if correct amount of shims is placed under bearing cup carrier.
10. Check gear lash of assembly in following manner:
    a. With pinion gear and propeller shaft gear meshed, check for back lash by pulling up on drive shaft and pushing in on propeller shaft.
    b. Rotate drive shaft very lightly in both directions to feel gear lash. No more than .008" to .012" (.203mm to .305mm) play should be allowed for proper operation.
    c. If gear lash is less than .008" to .012", add a sufficient amount of shims under small bearing cup in gear housing and/or under drive shaft ball bearing to attain correct amount of gear lash and correct conical angle of gears.

    NOTE: Any change in shim thickness under small bearing cup in gear housing will change propeller shaft end play. If shims are removed from under bearing cup, shims must be removed from under large bearing cup carrier to attain proper end play, as outlined in preceding Step No. 9. If shims are added under small bearing cup, shims must be added under large bearing cup carrier. It is suggested that, after any changes in shimming which affect amount of gear lash, Steps No. 9 and 10, preceding, be repeated.

11. See "Drive Shaft Housing - Reassembly" for re-installing gear housing on drive shaft housing.

DRIVE SHAFT

REMOVAL

1. Remove 4 screws and magnet screw from drive shaft bearing and retaining plate on top of gear housing.
2. Hold drive shaft in vise (using jaw protectors) and remove pinion gear nut with socket and flex handle (nut is right hand thread). (Figure 1)
3. While still holding drive shaft in vise, place a thick block of wood on gear housing and tap block lightly and evenly until drive shaft is removed from housing. (Figure 2)
4. Press drive shaft bearing retaining plate from drive shaft bearings. (Figure 3)

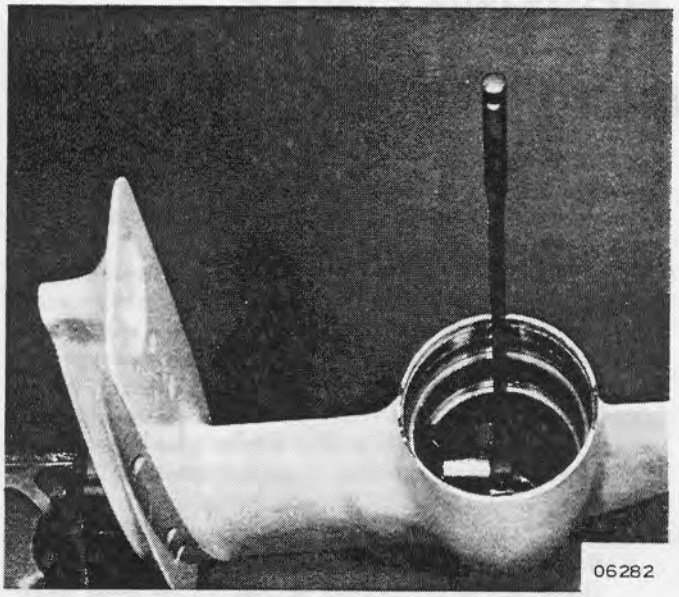


Figure 1. Removing Pinion Gear Nut

5. Check for shims which may adhere to bearings, retainer plate or gear housing. Keep upper and lower shims separate for reassembly.
6. Hold drive shaft in vise and remove large nut from top of drive shaft bearings (nut is left hand thread).
7. Remove large splined washer from drive shaft and press 2 tapered roller bearings and spacer from shaft.

NOTE: Two bearing assemblies and spacer make up a set and are not sold separately. Make certain that bearings and bearing cups are not separated or interchanged.

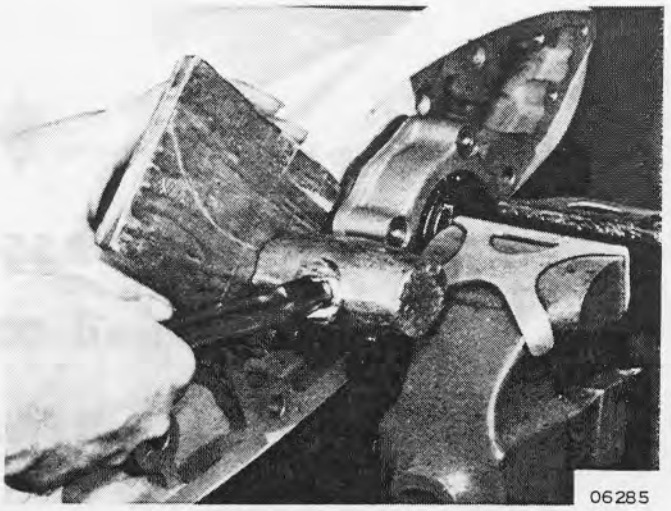


Figure 2. Removing Drive Shaft

8. Use Rod Driver (C-91-37323) with Bearing Driver Cup (C-91-38918), flat side to bearing, to drive needle bearing from gear housing.

This completes disassembly of gear housing. All parts now should be washed in cleaning solvent and inspected for wear, replacing parts which are worn and damaged beyond reuseable condition.

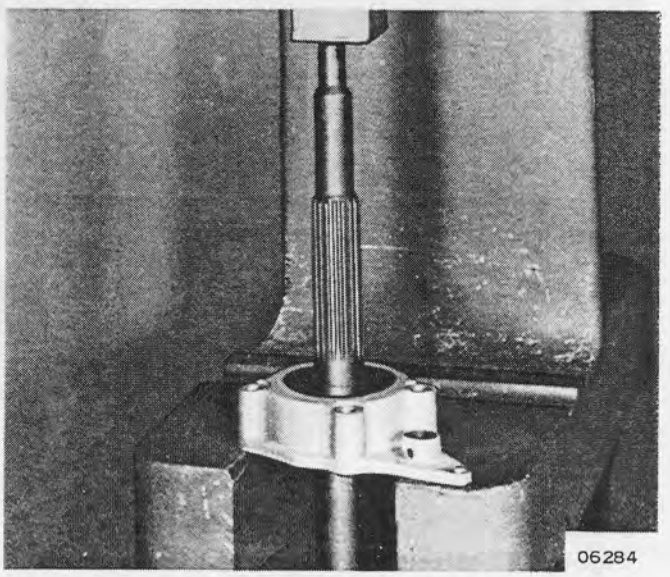


Figure 3. Removing Drive Shaft Bearing Retaining Plate

REASSEMBLY

1. Press 2 drive shaft tapered bearings and spacer onto shaft. (Figure 4)

   NOTE: Two bearing assemblies make up a set and are not sold separately. Make certain that bearings and bearing cups are not separated or interchanged. Bearings will have a preload after tightening nut in Step No. 2.

2. Install splined washer and nut on drive shaft and torque to 250 ft. lbs. (34.5mkg) (nut is left hand thread).
3. Place shims, which were previously removed, into drive shaft bearing recess, lubricate outside of bearings and install drive shaft and bearing assembly into gear housing.

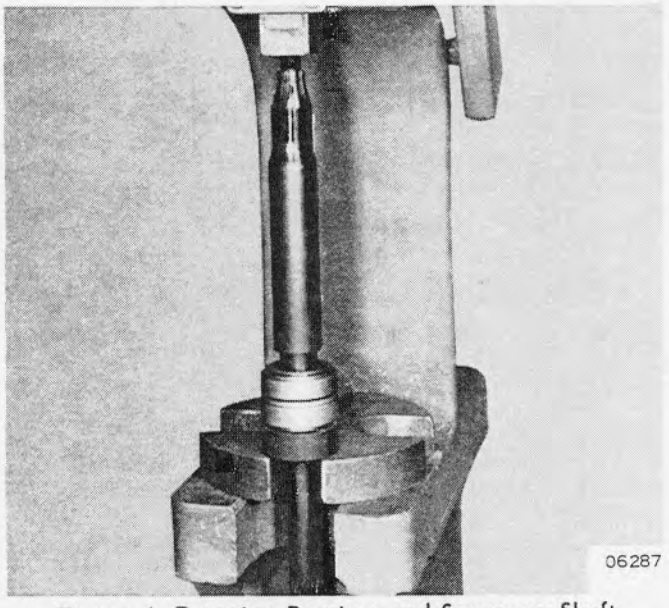


Figure 4. Pressing Bearings and Spacer on Shaft

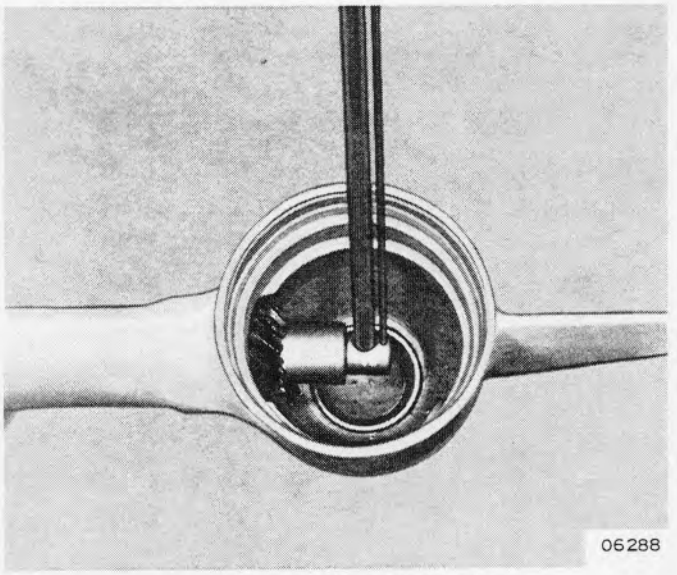


Figure 5. Installing Pinion Gear

4. Place shims on top of ball bearing to prevent bearing from moving up or down when retaining plate is tightened. To determine correct shim thickness, it is necessary to over-shim and place retainer on top of ball bearing. Press retainer down firmly and, with a feeler gauge, measure gap between retainer and mating surface of gear housing. Remove shims equal in thickness to amount of gap between retainer and gear housing.
5. Secure retainer to housing with hex head cap screws and lockwashers.
6. Clamp shaft in vise jaw protectors and tighten securely.
7. Place pinion gear on drive shaft and thread pinion retaining nut on drive shaft with chamfered side of nut toward gear. Tighten nut with 1¼" socket wrench and torque to 150 ft. lbs. (20.7mkg). (Figure 5)

SECTION 6 - DRIVE SYSTEMS

MERCRUISER

PART D - MERCRUISER III

MERCURY MARINE

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MERCRUISER III DRIVE UNIT

SERVICE RECOMMENDATIONS

This section includes all of the important detailed information pertaining to servicing the MerCruiser III Stern Drive Unit. Instructions are printed in the sequence which must be followed to assure best results when disassembling or assembling the unit. In order to assure correct and durable operation after assembling, it is important that all specifications stated herein -- pertaining to sizes, torque values and adjustments -- be maintained to the highest degree of accuracy.

Repair procedures for right hand rotation units and for left hand rotation units are noted.

Use special service tools where specified, ¾" drive and common tools of proper fit when removing and replacing parts.

When bearings are removed from housings or assemblies, keep them together with original shims for replacement in reassembly. If a new part was added to the assembly, reshimming will be necessary to obtain proper bearing preloads or gear backlash. (Refer to appropriate section of the MerCruiser Service Manual for these procedures.) Keep bearing assemblies and spacer components in removal order for reassembly. Bearing assemblies must be replaced as a unit.

When holding housings or parts in a vise -- or by other means – use blocks of wood and/or brass shields to prevent marring parts' surfaces. Since removal of pressed-on parts (bearings, gears, etc) require adapting appropriate mandrels and supports for the press used, do not apply force on the bearing cages, mating surfaces or edges which will mar or fail if force is applied.

Clean parts with cleaning solvent before inspection and perform repairs on a clean bench area. Foreign matter can cause false shimming indications and/or premature bearing failures. Lubricate parts with oil or grease to ease installation, retard rust, etc. Except when installing oil seals, they require Loctite "A" (C-92-32609) on seal outside diameter to prevent lubrication seepage and hold seal securely in position.

Remember - "An ounce of prevention is worth a pound of cure". . . during repairs. Be sure to drain gear lube before separating drive unit housing for repairs. Housings, which require repair, should be installed on Stern Drive Work Stand (C-91-33750) with Adaptor (C-91-52569A1). (Figure 1)

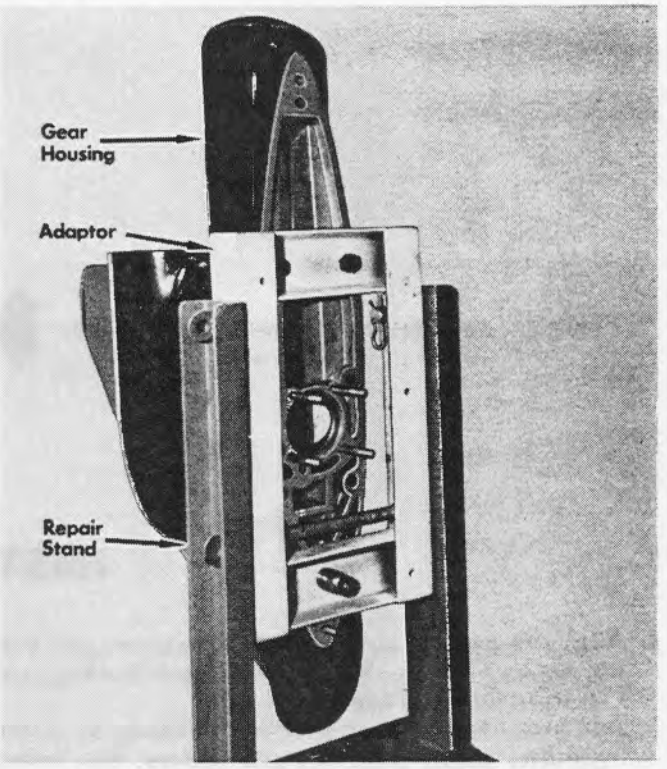


Figure 1. Gear Housing Installed on Work Stand

GEAR HOUSING

REMOVAL

To ease removal of gear housing from a complete drive installation, tilt drive unit "up" with hydraulic system, then separate housings, as follows:

1. Remove propeller and trim tab.
2. Remove allen head screw and elastic stop nuts which hold the gear housing. (Figure 1) Prepare to support the gear housing so that it will not fall when separated from the drive housing.

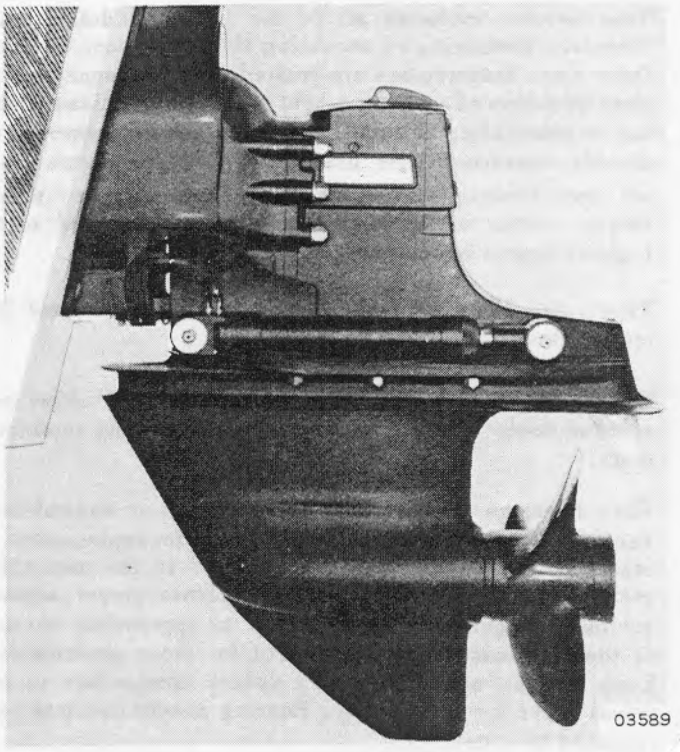


Figure 1. Gear Housing Assembly on Drive Unit

INSTALLATION

1. Align new gasket on drive shaft housing to gear housing mating surface. Before joining gear housing, position trim tab allen head screw.
2. Join gear housing and drive shaft housing by inserting drive spline shaft into gear splines, then install and tighten nuts and screw which were removed previously.
3. Fill drive unit with fresh Super-Duty Gear Lubricant (C-92-52650 tube, C-92-52655 qt. can) check reservoir level and install propeller and trim tab.

DISASSEMBLY and REASSEMBLY

PROPELLER SHAFT and BEARING CARRIER

REMOVAL

RIGHT HAND ROTATION

1. If gear housing cover retainer has lock tab, bend it back before removing cover retainer with Gear Case Cover Tool (C-91-52141). (Figure 2)
2. Remove bearing carrier, "O" ring and thrust ring, gear and propeller shaft. (Figures 3 and 4)
3. Slip bearing carrier assembly from propeller shaft and, if necessary, remove bearing cup with slide hammer puller. (Figure 5) Remove seals and needle bearing with Sleeve (C-91-48633) and rod. (Figure 6)
4. Remove adaptor and roller bearing from gear housing and remove anchor pin and push sleeve from adaptor

as in (Figure 7).

5. Remove front bearing cup with Slide Hammer (C-91-34569A1) and remove shims from housing.

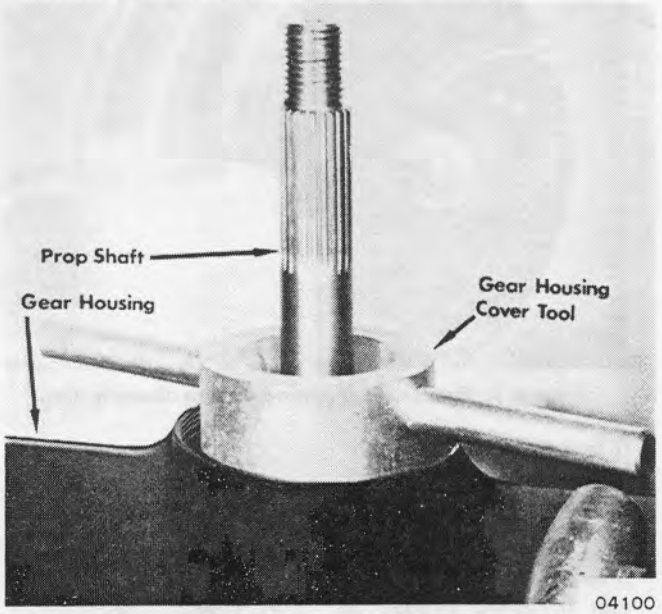


Figure 2. Removing Gear Housing Cover

NOTE: Some MerCruiser III units (Serial No. 2373127 thru 2373426) have experienced a wear condition on the bearing adaptor. When servicing a MerCruiser III unit (Serial No. 2373127 thru 2373426), check the drive unit gear housing and replace bearing adaptor (B-48010) with bearing adaptor B-53515A1. Bearing adaptor (B-53515A1) includes a splined thrust washer on the propeller shaft next to the adaptor to provide for a harder-wearing surface between the propeller shaft spacer and adaptor. Wearing of the propeller shaft adaptor will cause premature gear failure.

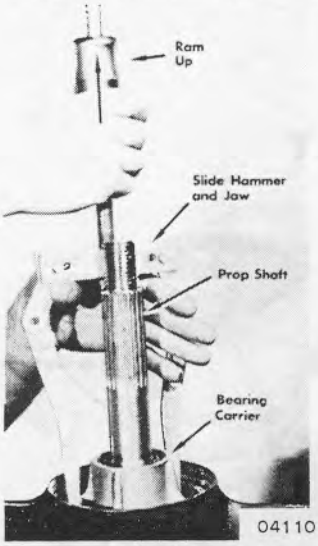


Figure 3. Removing Bearing Carrier

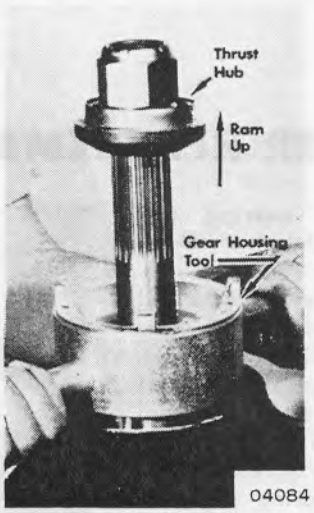


Figure 4. Removing Bearing Carrier with Propeller Shaft

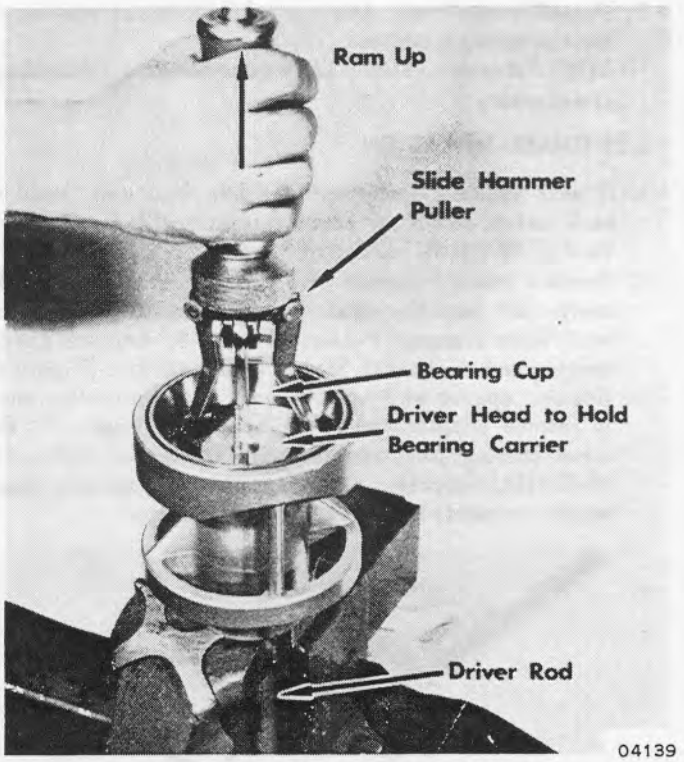


Figure 5. Removing Bearing Cup

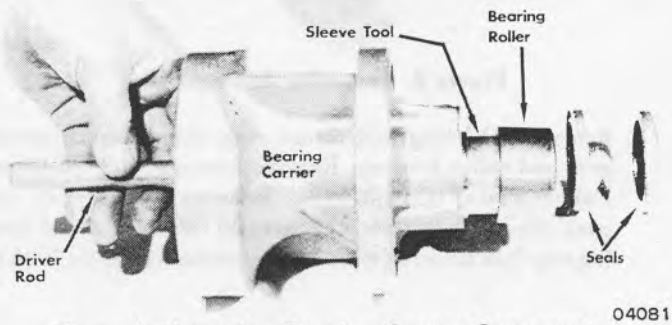


Figure 6. Removing Bearing Carrier Components

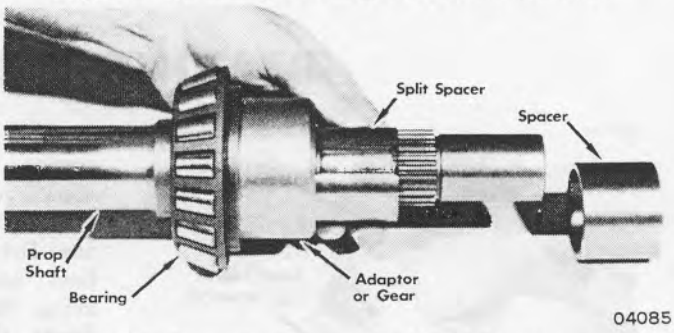


Figure 7. Removing Propeller Shaft Components

NOTE: Use caution when removing front bearing cup to avoid damage to pinion gear and/or cup.

6. Remove spacer and split spacer from propeller shaft to remove gear and roller bearing, as shown in Figure 7.

7. Propeller shaft may have a splined thrust washer on front of bearing adaptor.
   NOTE: Remove drive shaft components, following, if necessary.

LEFT HAND ROTATION

1. If gear housing cover retainer has lock tab, bend it back before removing cover retainer with Gear Cover Tool (C-91-52141). Refer to Figure 2.
2. Remove bearing carrier with propeller shaft, then slip carrier off propeller shaft. Remove carrier bearing cup with Slide Hammer Puller. (Figure 8) Remove needle bearing and seals with Sleeve (C-91-48633). (Figure 6)
3. Remove spacer and split spacer from propeller shaft to remove adaptor and roller bearing. (Figure 7) Remove bearing from adaptor with Universal Puller (C-91-37241). Propeller shaft may have a splined thrust washer on shaft in front of bearing adaptor.

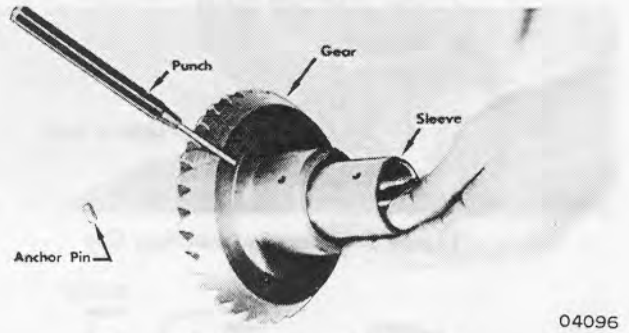


Figure 8. Removing Anchor Pin

4. Remove "O" ring and thrust ring shims, then forward gear and roller bearing. Remove bearing with Universal Puller Plate (C-91-37241). Remove anchor pin and push sleeve from gear. (Figure 8) Remove front bearing cup from housing with Slide Hammer (C-91-34569A1).

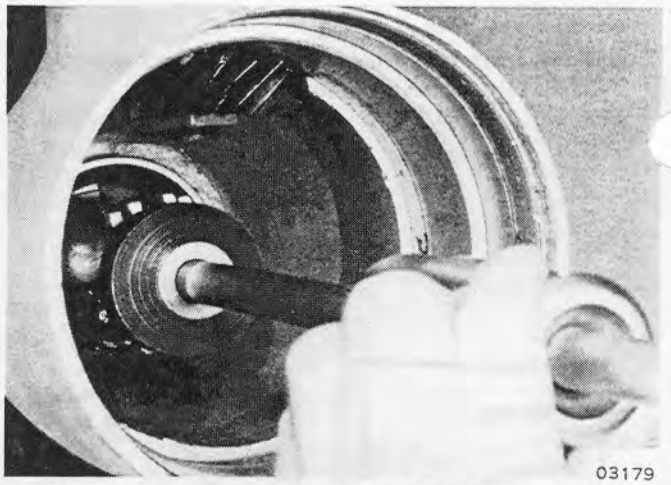


Figure 9. Removing Tapered Roller Bearing Cup

(Figure 9) Remove drive shaft components, following, if necessary.

NOTE: Use caution when removing front bearing cup to avoid damage to pinion gear and/or cup.

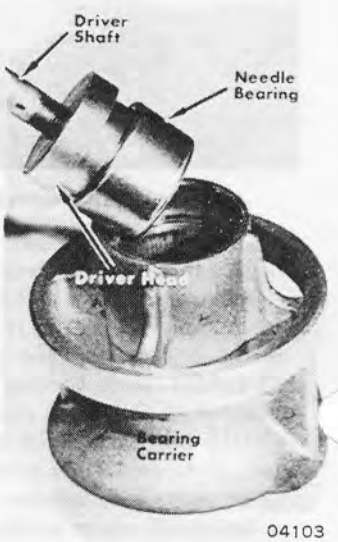


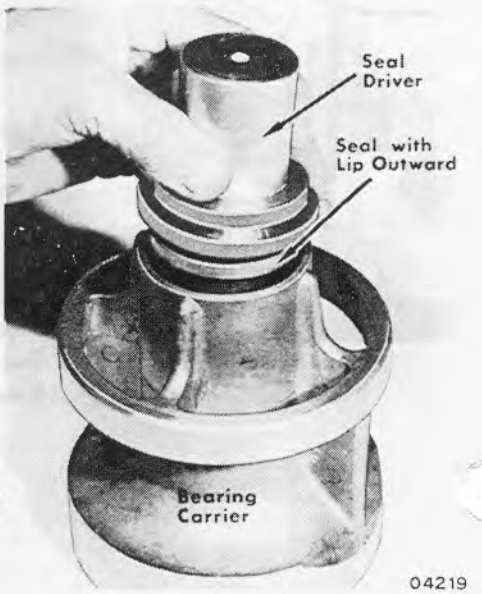
Figure 10. Installing Needle Bearing into Carrier

BEARING CARRIER REASSEMBLY

1. Press needle bearing into carrier with Adaptor (C-91-48632). (Figure 10)
2. Press in oil seals with Oil Seal Driver (C-91-48622). Seat first seal with lip inward, using deep shoulder side of driver, then seat second seal with lip outward, using opposite end of driver. (Figures 11 and 12)
3. Press rear bearing cup into carrier with Cup Driver (C-91-48619)

Figure 11. Seating First Seal

Figure 12. Seating Second Seal



PROPELLER SHAFT REASSEMBLY

(With Drive Shaft Installed)

RIGHT HAND ROTATION

1. Push sleeve into bearing adaptor so that pin can be inserted. (Figure 13)

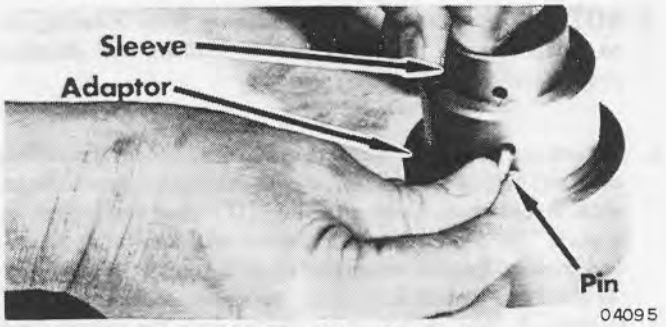


Figure 13. Installing Pin in Adaptor

2. Press front bearing cup into housing with original shims or .025" shims (Figure 14), then front roller bearing on adaptor, and place it in front bearing cup.
3. Press rear roller bearing onto gear, then place it on propeller shaft and lock it in place with split spacer and spacer. Also place splined thrust washer on propeller shaft, if one was removed in disassembly with bearing adaptor.
4. Place assembled propeller shaft into gear housing and bearing adaptor. Install "O" ring (shims and thrust ring, if removed), bearing carrier assembly, key, (tab) washer and cover.
5. Rotate propeller shaft as cover is being tightened. Torque to 200-250 ft. lbs. (27.6-34.5mkg) with Tool C-91-52141. (Figure 2)
   NOTE: If drive shaft or pinion gear has been replaced, check shimming pinion gear, following.

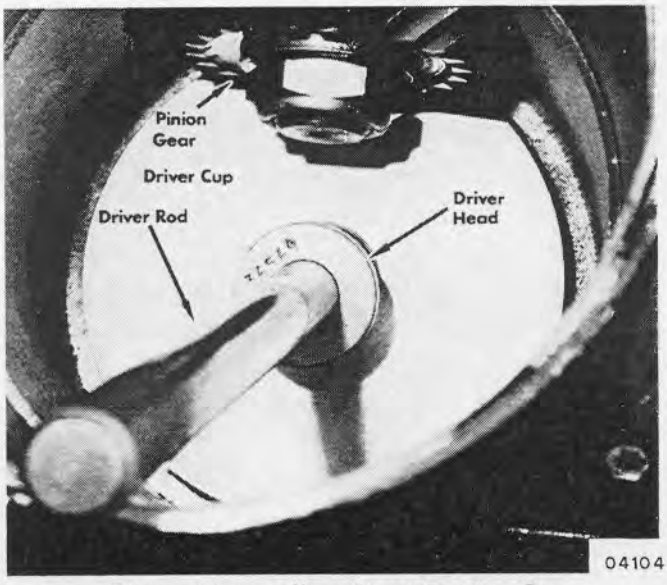


Figure 14. Installing Front Bearing Cup

SHIMMING and PRELOAD

1. If shims or component propeller shaft parts were changed, check gear backlash with a dial indicator and Tool C-91-53459. (Figure 15) Add or subtract shims from under front bearing cup to obtain a gear clearance of .008" to .012" (.2 to .3mm) at 1-11/16" (43mm) radius. Reinstall and torque cover nut to 200-250 ft. lbs. (27.6-34.5mkg) with Tool C-91-52141. (Figure 2)

   NOTE: Use caution when removing front bearing cup to avoid damage to pinion gear or bearing cup. Observe removal procedure, preceding.

2. Determine propeller shaft bearing preload by installing original shims or .035" (.89mm) in gear housing with thrust ring. Lubricate "O" ring, bearing carrier with key, tab washer and cover. Rotate propeller shaft as cover is being tightened. Torque to 200-250 ft. lbs. (27.6-34.5mkg). If propeller shaft tightens before cover is tightened, add shims under thrust ring for proper "preload", following in Paragraph "3". If propeller shaft is loose after cover is tightened, remove shims from under thrust ring for proper "preload", following. Check gear backlash to be sure that it has not changed.

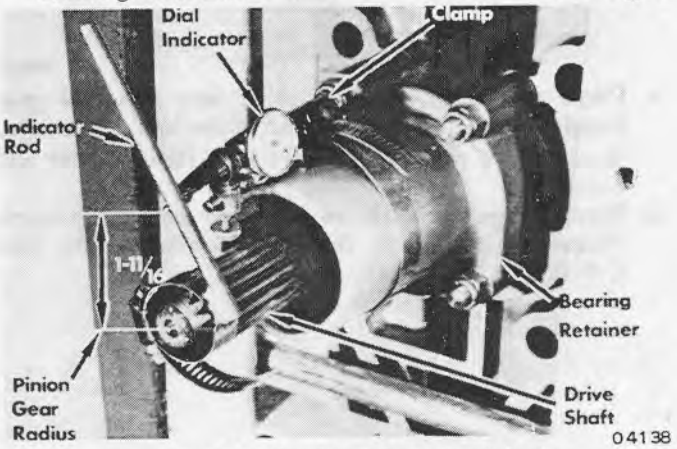


Figure 15. Checking Gear Backlash

3. Use Torquing Tool (C-91-48606) with torque wrench and reducers to determine gear housing bearing preload. Torque value on new bearings and gears is 35 in. lbs. (6.2 kg/cm) (plus-or-minus 5 in. lbs.) (.89-kg/cm) at the drive shaft. Torque value on original bearings and gears is 15 in. lbs. (2.66 kg/cm) (plus-or-minus 5 in. lbs.) at the drive shaft. (Figure 16)

Completes reassembly of right hand rotation housing.

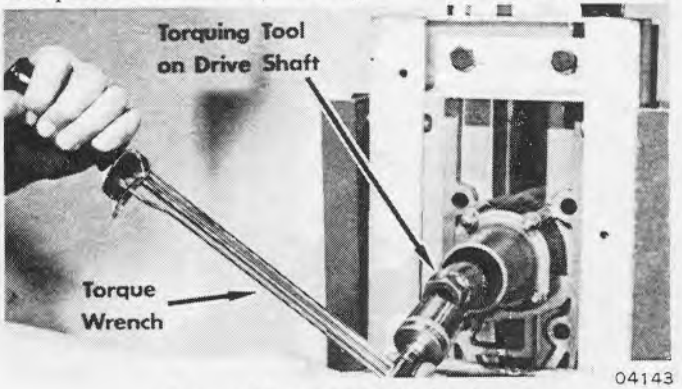
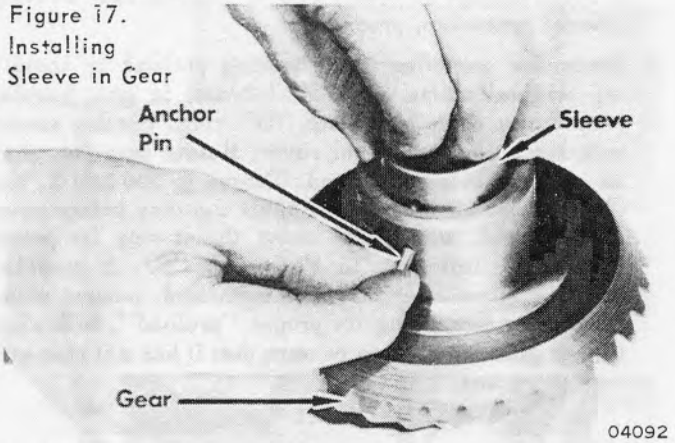


Figure 16. Bearing Preload

LEFT HAND ROTATION

1. Push sleeve into gear so that anchor pin can be inserted. (Figure 17)
2. Press front bearing cup into housing (Figure 14), then front roller bearing on gear and place it in front bearing cup.
3. Press rear roller bearing onto bearing adaptor and place it on propeller shaft, locking it in place with split spacer and spacer. (Figure 7) Place splined thrust washer on propeller shaft, if one was removed in disassembly with bearing adaptor, before installing split spacer and spacer on propeller shaft.

Figure 17. Installing Sleeve in Gear



4. Place assembled propeller shaft into gear and gear housing. Install thrust ring with shims and "O" rings, then bearing carrier assembly, key, (tab) washer and cover.
5. Rotate propeller shaft as cover is being tightened. Torque to 200-250 ft. lbs. (27.6-34.5mkg) with Tool C-91-52141. (Figure 2)

SHIMMING and PRELOAD

1. If shims or component propeller shaft parts were changed, check gear backlash with a dial indicator and Tool (C-91-53459). (Figure 18) Add or subtract shims from under front bearing cup to obtain a gear lash of .008" to .012" (.2 to .3mm) at a 1-11/16" (43mm) radius. Reinstall and torque cover nut to 200-250 ft. lbs. (27.6-34.5mkg) with Tool C-91-52141.

   NOTE: Use caution when removing front bearing cup to avoid damage to pinion gear or bearing cup. Removal procedure precedes.

2. Determine propeller shaft bearing preload by installing original shims or .035" (.89mm) shims in gear housing with thrust ring. Lubricate the "O" ring well, then reinstall "O" ring, bearing carrier with key, tab washer and cover. Rotate propeller shaft as cover is being retorqued. If propeller shaft tightens before cover is tightened, add shims under thrust ring for proper "preload", following in Paragraph 3. If propeller shaft is loose after cover is tightened, remove shims from under thrust ring for proper "preload", following. Check gear backlash to be sure that it has not changed.

3. Use Torquing Tool (C-91-48606) with torque wrench and reducers to determine gear housing bearing preload. Torque value on new bearings and gears is 35 in. lbs. (6.2 kg/cm) (plus-or-minus 5 in. lbs.) (.89-kg/cm) at the drive shaft. Torque value on original bearings and gears is 15 in. lbs. (2.66 kg/cm) (plus-or-minus 5 in. lbs.) at the drive shaft.

   This completes reassembly of left hand rotation gear housing.

DRIVE SHAFT

REMOVAL

NOTE: Follow "Propeller Shaft Removal", preceding.

1. Use Tool C-91-48606 to hold drive shaft (Figure 1) when removing pinion nut, belleville washer and gear.
2. Remove 4 elastic stop nuts and bearing retainer shims, then "O" rings and drive shaft from housings.

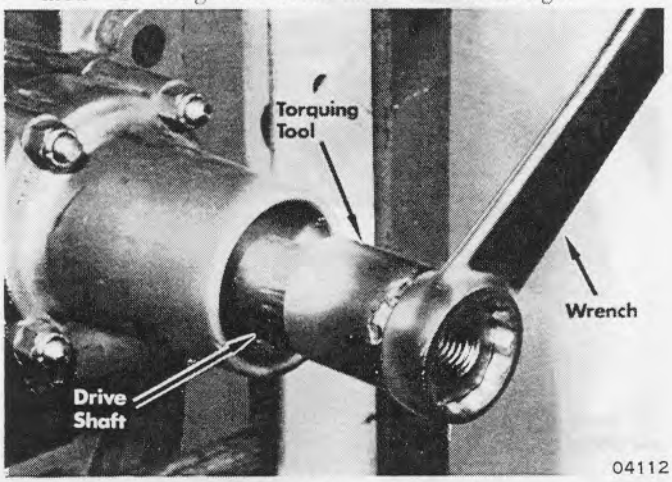


Figure 1. Holding Drive Shaft

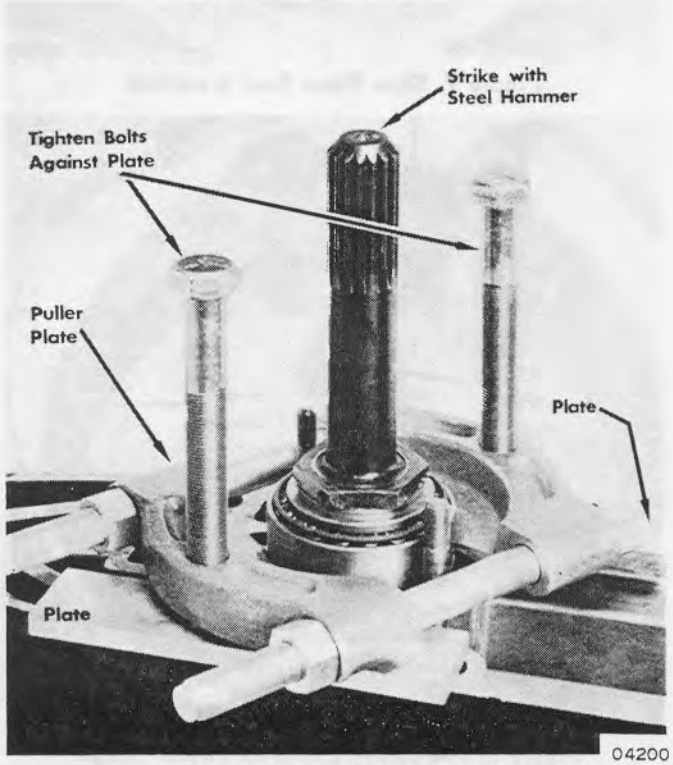


Figure 2. Removing Drive Shaft Pinion Gear

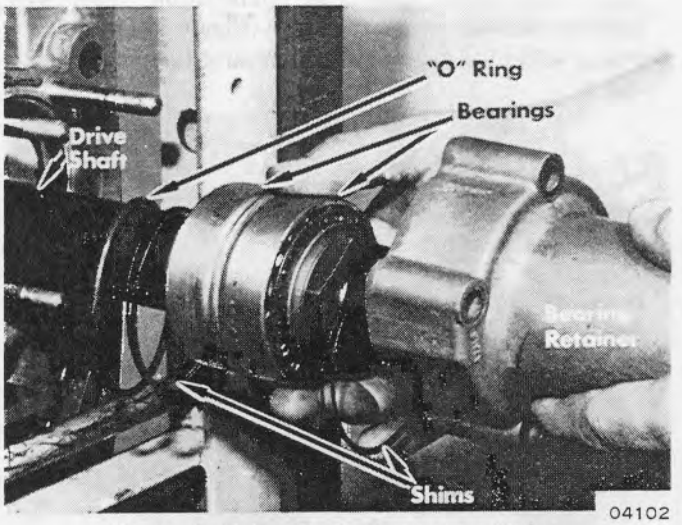


Figure 3. Drive Shaft Component Order

3. Remove pinion gear (if it is not loose) with Universal Puller Plate (C-91-37241) and 2 bolts (5/8x18 thread).

   Use 2 plates to protect housing when tightening bolts securely against housing. (Figure 2) Strike top of drive shaft a sharp blow with a steel hammer to break gear loose.

   NOTE: Shims in retainer end and gear housing end should not be mixed. (Figure 3)
4. Bearing retaining nut is left hand. (Figure 4) Remove nut and spline belleville washer. Cup should be up on washer. Next, press bearing assemblies off shaft.
5. Use drive tool to remove pinion roller bearing. (Fig. 5)

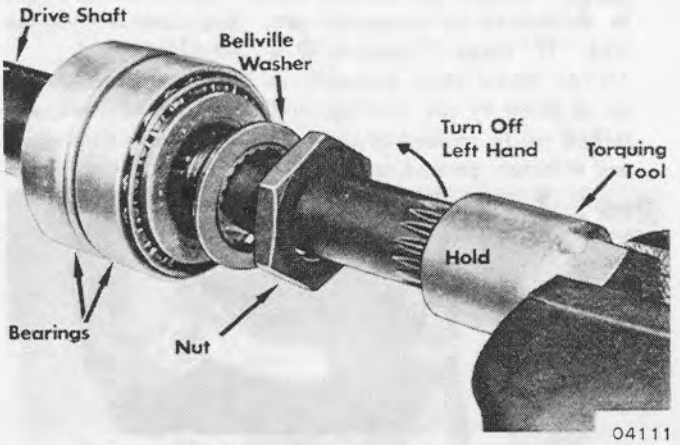


Figure 4. Removing Bearing Assemblies

REASSEMBLY

1. Pull in pinion roller bearing with Puller Head (C-91-38762). Numbered side on bearing cage always faces away from pinion gear after installation. Tool will position bearing at proper depth. (Figure 5)
2. Press roller bearings with spacer on drive shaft. (Figure 3)

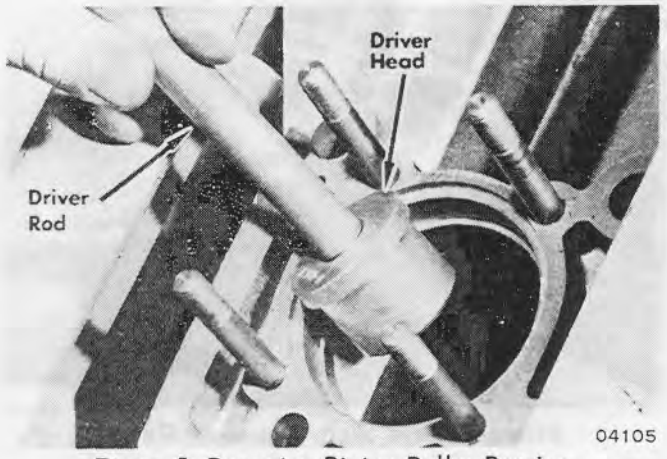


Figure 5. Removing Pinion Roller Bearing

3. Place splined washer (dish up) and special lock nut (left hand) on drive shaft. Use Torquing Tool (C-91-48606) to hold drive shaft, then torque to 200 ft. lbs. (27.6mkg).
4. Place original shims or .020" (.51mm) shims in gear housing recess, then insert drive shaft assemblies and "O" ring.
5. Place original shims in bearing retainer and place retainer in position over drive shaft with "O" rings. Torque nuts to 30 ft. lbs. (4.14mkg).

   To reshim bearing retainer, place a sufficient amount of shims into bearing retainer to overshim it when placed in position. Hold retainer firmly in place and measure gap between retainer and housing with feeler gauge. (Figure 6) Remove shims from retainer equal in thickness to measured gap, then install retainer with "O" rings. Torque to 30 ft. lbs. (4.14mkg).

   NOTE: Drive shaft assembly is prevented from moving up or down by the bearing retainer. If shims were disturbed while shimming pinion gear, reshim drive shaft and retainer, preceding.

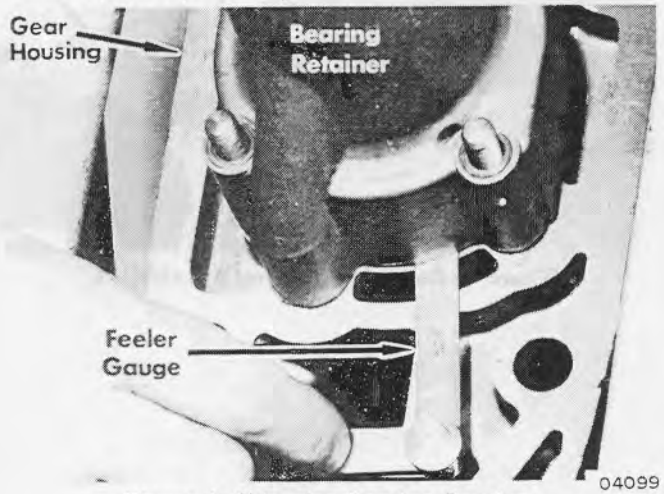


Figure 6. Shimming Bearing Retainer

6. Install pinion gear, washer, elastic stop nut on drive shaft and secure with 175 ft. lbs. (24.2mkg) torque.
7. Install Shimming Tool (C-91-52135A1) into gear housing. Front bearing cup must be removed so the Front Plate (C-91-52136) of C-91-52135A1 may be installed. (Figure 7)

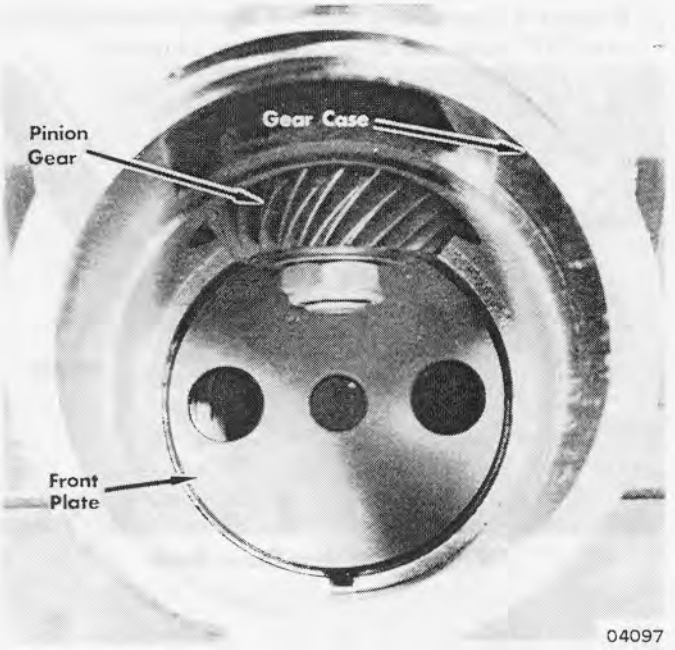


Figure 7. Shim Plate Tool Installed

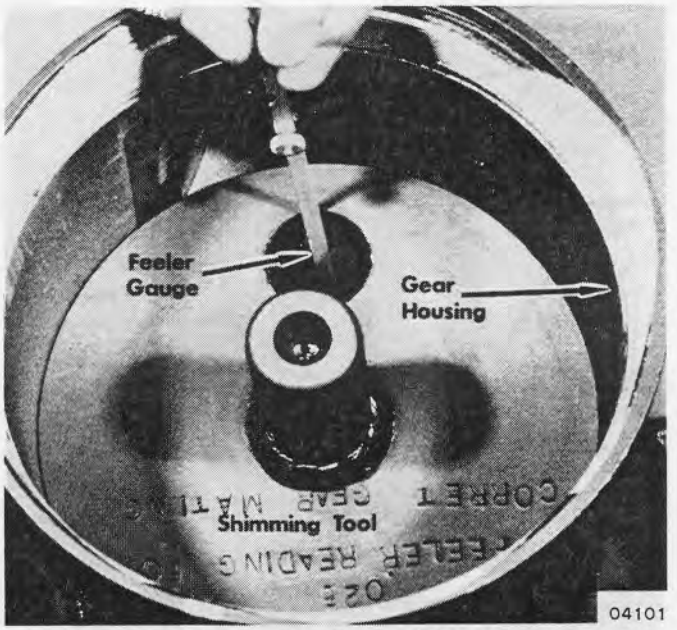


Figure 8. Measuring Cap with Feeler Gauge

8. Measure gap between pinion gear and tool surface with feeler gauge. Correct gap is .025" (.64mm) (Figure 8) If gap is not correct, remove drive shaft assembly, and remove or add shims under assembly to obtain proper .025" gap when drive shaft is installed.

Refer to "Propeller Shaft Component Reassembly", preceding, to complete gear housing reassembly and reinstallation.

DRIVE SHAFT HOUSING

REMOVAL

1. Remove nuts from trim cylinder aft anchor pin and disconnect trim cylinders.
2. Remove 6 elastic stop nuts from drive shaft housing to bell housing studs and remove drive shaft housing.
3. Separate gear housing from drive shaft housing as outlined in "Gear Housing, Removal and Installation", preceding.

INSTALLATION

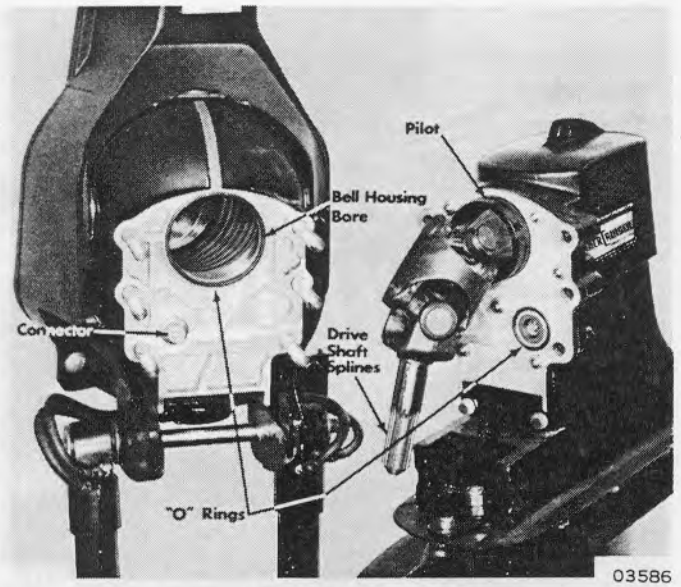


Figure 1. "O" Ring Positions

1. Remove all packaging pieces, caplug, etc, from gimbal housing.
2. Retain packaging for future use; i.e., shipping, storage, etc.
3. Lubricate land on drive shaft housing pilot (Figure 1) and drive shaft splines with New Multipurpose Lubricant (C-92-49588). Apply light coating of lubricant to inside surfaces of bell housing bore.
4. Check that "O" rings stay seated in grooves for sealing, or leakage will result. (Figure 1)

   NOTE: Use hoisting equipment to hold drive during installation.
5. Insert stem drive unit into drive shaft housing bell bore (Figure 2) by guiding drive shaft thru guide spring in engine drive coupling. If drive shaft splines do not align with engine coupling splines, rotate propeller shaft in either direction slightly until drive unit can be pushed into position. Propeller should be placed on shaft for easier rotation.
6. Fasten drive shaft housing to bell mounting bolts with 6 elastic stop nuts and flat washers. Tighten evenly to 100 ft. lbs. (6.9mkg) torque. Refer to Figure 3.

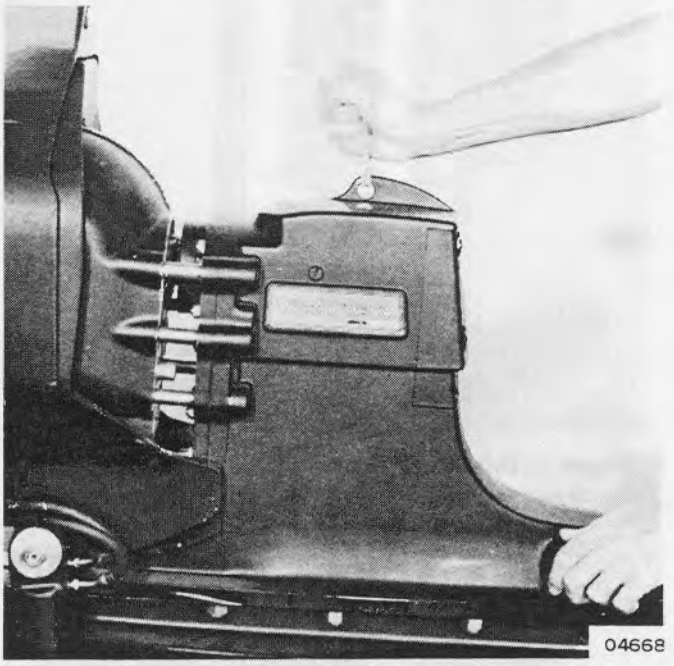


Figure 2. Inserting Unit into Bell Bore

7. Install trim cylinders to anchor pin. Refer to Section 2 - " Removal, Installation and Alignment".

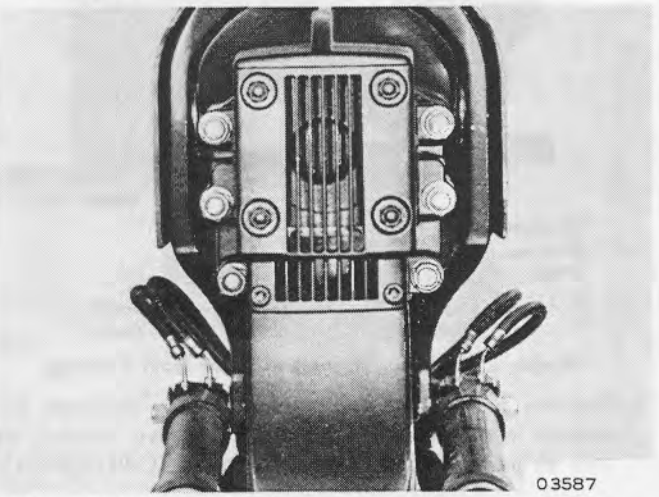


Figure 3. Drive Shaft Housing to Bell Mounting Bolts

DISASSEMBLY

REMOVING DRIVING GEAR and UNIVERSAL JOINT

1. Mount drive shaft housing to Adaptor (C-91-52569A1) and install on Drive Work Stand (C-91-33750). (Figure 1)

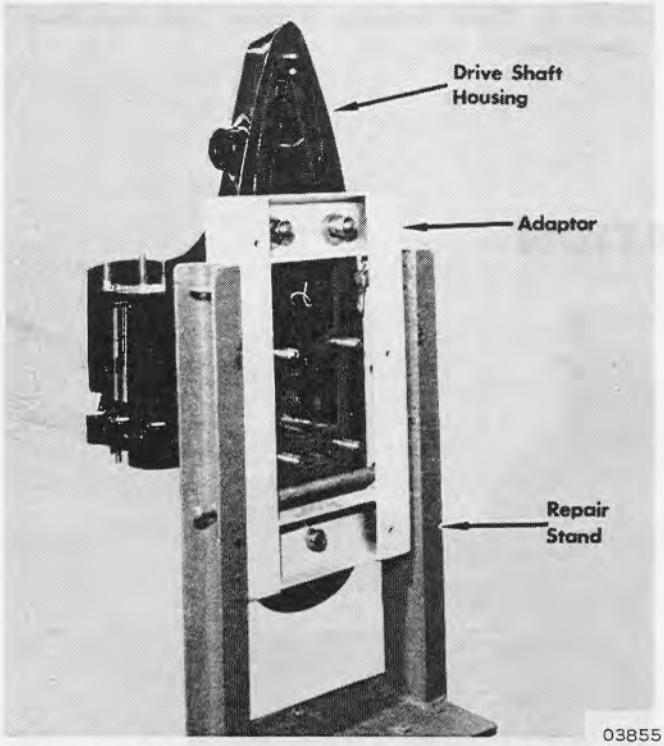


Figure 1. Drive Shaft Housing Installed on Work Stand

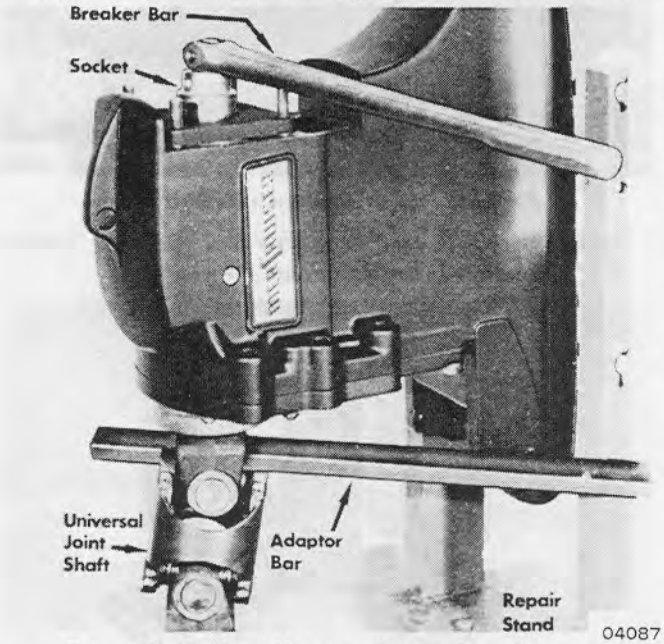


Figure 2. Holding Universal Joint from Turning

2. Remove back cover to expose bearing retainer, then remove retainer with "O" ring. Remove bearing cup and shims with Slide Hammer Puller (C-91-34569A1).
3. Install Retainer Tool (C-91-53118A1) to hold universal joint shaft when removing shaft lock nut. Use adapto bar against workstand to hold universal joint from turning. (Figure 2) Use a soft drift to free drive shaft if tight on driver gear. When replacing universal joint cross bearings, use the tool less its adaptor. (Refer to universal joint repair procedure, Section X, MerCruiser Service Manual.)
4. Remove retainer "driving gear", spacer and bearing from housing. Use Universal Puller Plate (C-91-37421) to remove bearing from gear. (Figure 3) Use Slide Hammer Puller (C-91-34569A1) to remove bearing cup and shims from housing. Drive U-joint shaft seal in toward housing to remove.

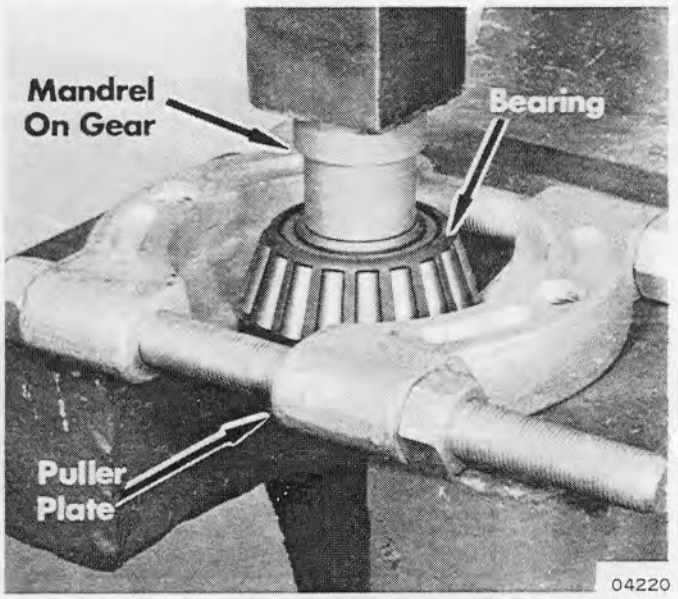


Figure 3. Removing Bearing from Gear

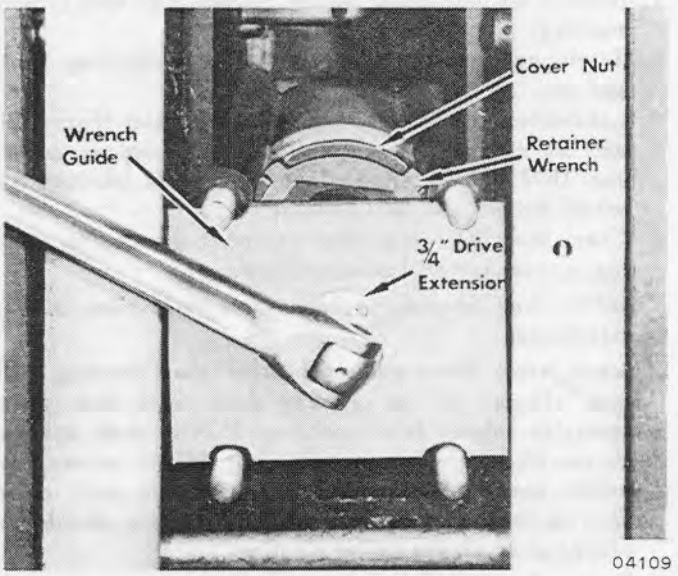


Figure 4. Removing Cover Nut

REMOVING DRIVEN GEAR

1. Remove cover nut with tools of (C-91-48614A1) (Figure 4), then remove washer, seal and bearing adaptor with "O" ring (Figure 5).

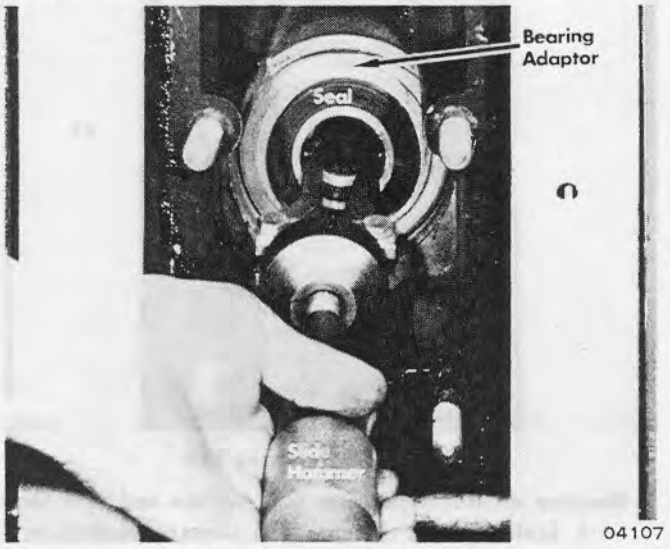


Figure 5. Removing Bearing Adaptor

2. Use C-91-48614A1 tools. Insert Tool (C-91-52137) in thru bottom of gear and hold gear with Torque Tool (C-91-48606) while turning locking nut counterclockwise (left hand thread). (Figure 6)

   NOTE: Protect housing from damage by reinstalling Retainer Tool (C-91-53118A1).

3. Remove locking nut, cup washer, roller bearing and spacer.
4. Remove "driven gear" and roller bearing. Use Bearing Puller Plate (C-91-37241) to remove bearing from gear.
5. Pull roller bearing cups with shims and outside spacer from housing by placing driven gear roller bearing in cup with a puller head and pilot washer in Rod Assembly (91-31229A4). (Figure 7)
6. Remove front cover nuts, then remove "O" rings, quadring valve parts and oil seal.

This completes disassembly of drive shaft housing.

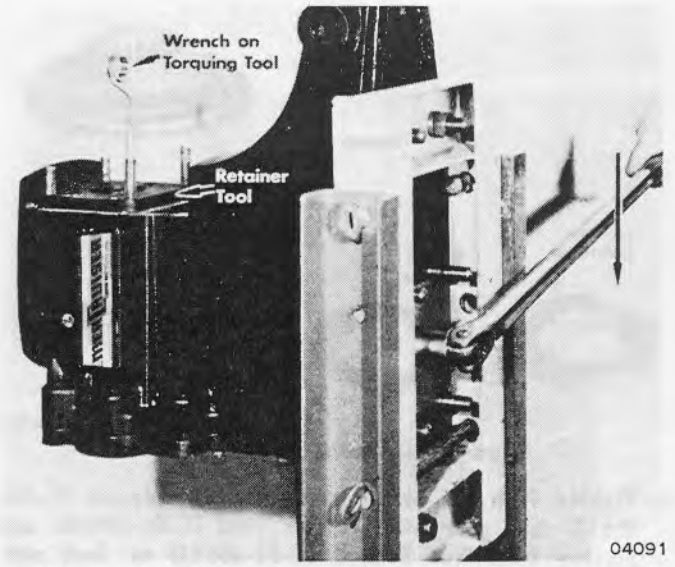


Figure 6. Holding Gear and Turning Locking Nut

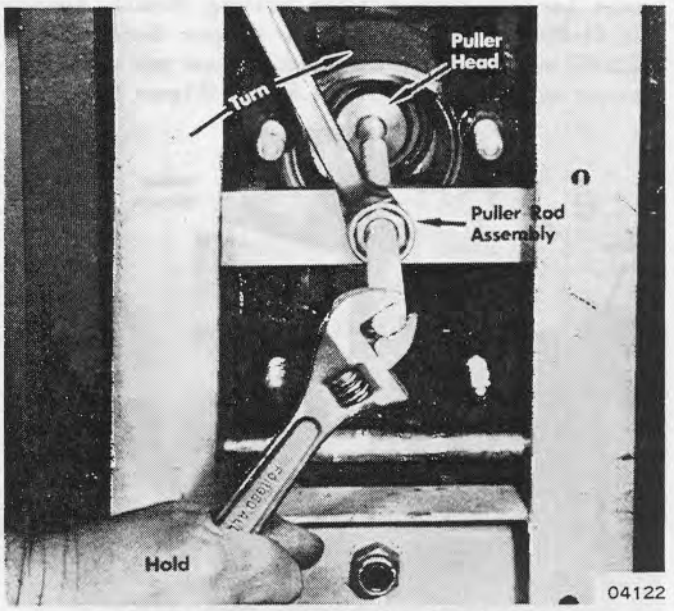


Figure 7. Removing Roller Bearing Cups

REASSEMBLY

Install drive shaft housing on Work Stand and Adaptor (C-91-52569A1) as shown in Figure 1, preceding.

NOTE: Remove lower pin in work stand adaptor and rotate housing to a 90° position. Place adaptor bar over rear cover studs to hold drive.

GEAR and BEARING REASSEMBLY

1. Place original shims into housing. If original shims were lost or, if bearing assemblies and spacers have been replaced, check gear shimming, backlash and preload.
2. Use Driver Tool (C-91-49994) for installing bearing cups and spacer in this order. Refer to Figure 8. Install first bearing cup with taper into housing, spacer and second bearing cup with taper to Driver Tool (C-91-49994).
3. Press tapered roller bearing onto "driven gear" with large diameter of bearing toward gear.
4. Place gear assembly in thru rear of housing, then hold it in position to install inner spacer roller bearing, splined belleview washer with cup up and lock nut (left hand thread).

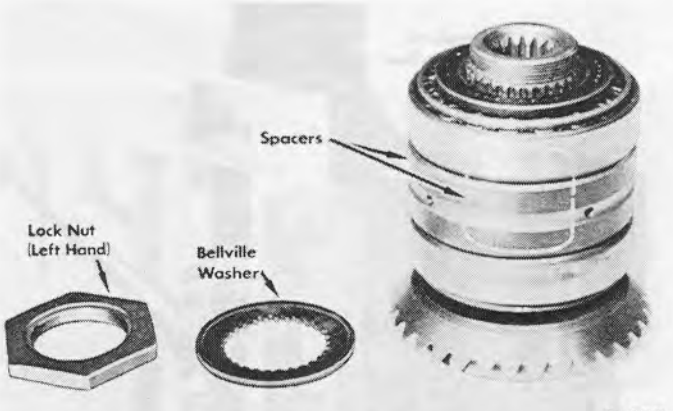


Figure 8. Driven Gear Assembly

5. Tighten lock nut by inserting Wrench Adaptor (C-91-48615) into gear with Torque Tool (C-91-48606) and placing Gear Nut Wrench (C-91-48614) on lock nut. Place Retainer Tool (C-91-53118A1) in position to prevent housing damage when holding Wrench Adaptor (C-91-48615). (Figure 9) Use Adaptor Guide (C-91-52147) and 3/4 drive extension in gear nut wrench to torque nut to 250 ft. lbs. (34.5mkg). (Figure 10)

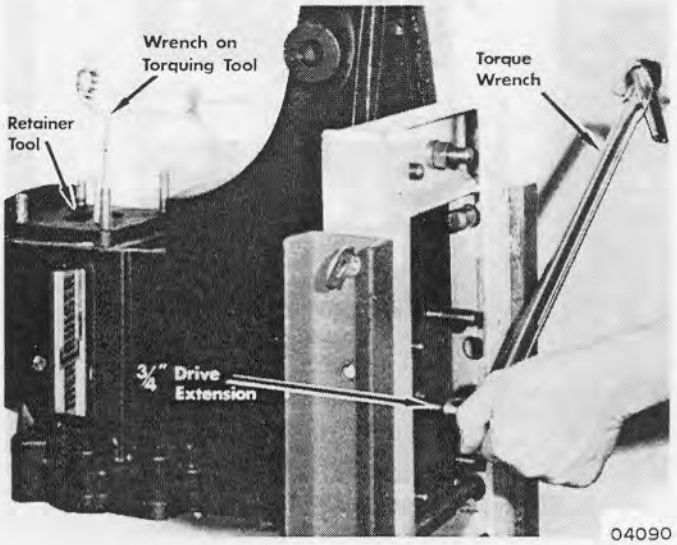


Figure 9. Retainer Tool in Position

6. Remove tools and install bearing adaptor anti-galling washer, seal and retainer. (Figure 10) Place gear nut wrench (C-91-48614) into retainer and torque to 200 ft. lbs. (27.6mkg).
7. Insert Shimming Tool (C-91-52137) into housing, aligning it for drive reduction. Small bearing cup must be removed.

Overall Reduction	Driven Gear	Driving Gear
1.5:1	27 Teeth	27 Teeth
2:1	32 Teeth	24 Teeth

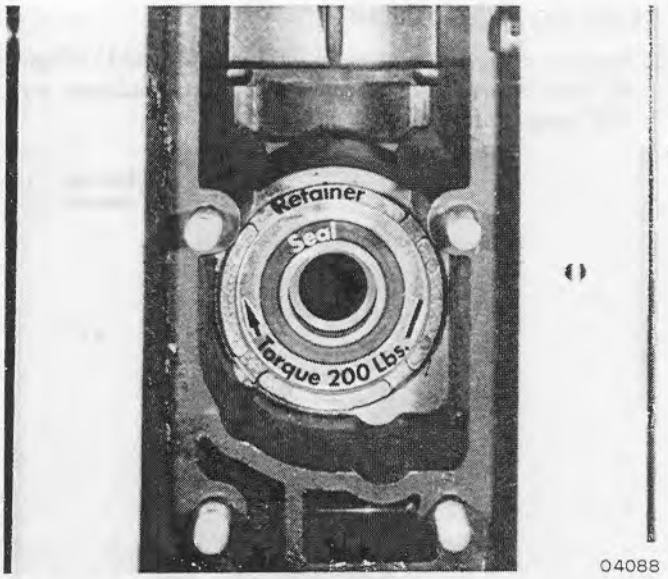


Figure 10. Torquing Nut

Measure clearance between tool surface and gear tooth with feeler gauge. (Figure 11) Correct clearance is .025" (.635mm). If clearance gap between tool and gear tooth is greater than specified, shims must be removed from under bearing cup equal in thickness to amount of feeler gauge reading over specified size. If gap is less than specified, shims equal in thickness to amount of feeler gauge reading less than specified size must be added under bearing cup.

NOTE: Follow driven gear assembly removal, preceding. When making any change in shim thickness, recheck clearance gap after reinstallation of components.

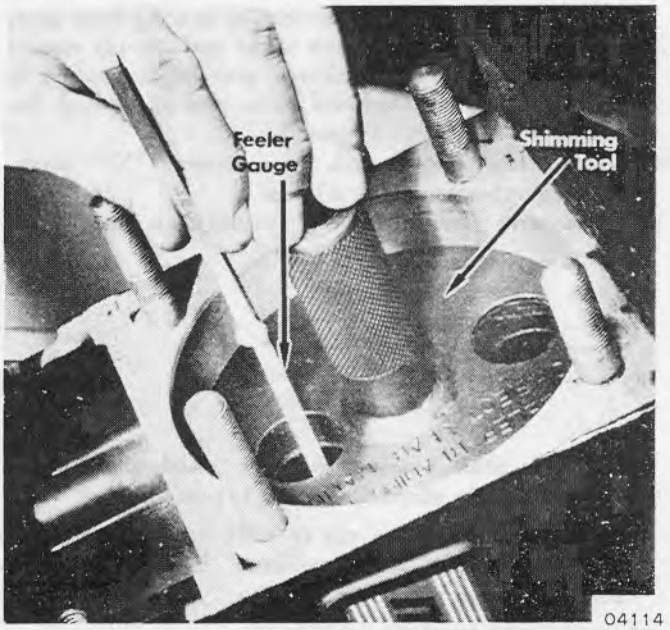


Figure 11. Measuring Clearance

UNIVERSAL JOINT SHAFT GEAR and BEARING SEAL REPLACEMENT

1. Remove universal joint, driving gear assemblies and front bearing cup, then remove seal.
2. Place Loctite "A" (C-92-32609) on seal case and in its housing recess before installing with Driver (C-91-48635) and rod. (Figure 1)
3. Reinstall universal joint shaft components, following.

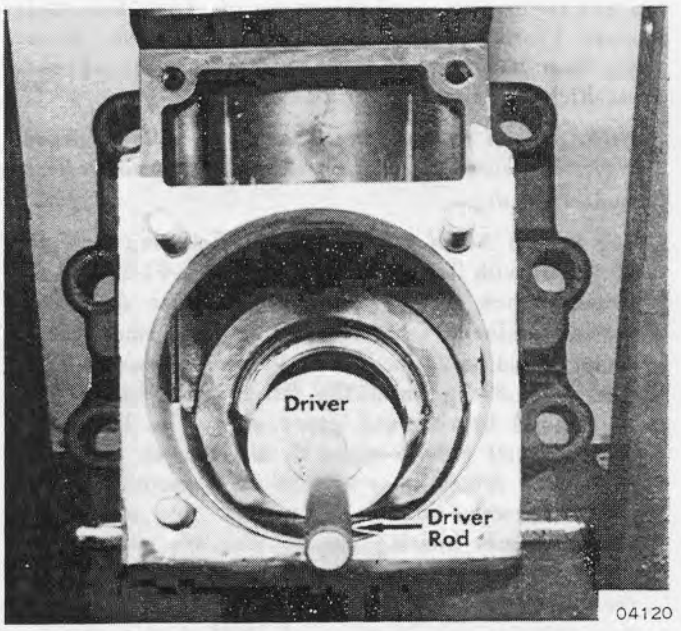


Figure 1. Installing Seal Case

UNIVERSAL JOINT SHAFT REASSEMBLY

1. Replace original shims or start reshimming by installing .028" (.81mm) shim under large cup of bearing retainer. Install cup with Driver Tool (C-91-49994). Replace original shims or start reshimming by installing .025" (.64mm) shim under small bearing cup in housing. Install cup with Driver Tool (C-91-33493).
2. Install tapered roller bearing onto driving gear with large diameter toward gear.
3. Insert universal joint shaft into housing, holding it in position while placing front tapered roller bearing, spacer and driving gear assembly on shaft. (Figure 2) Retain shaft with plain washer and elastic stop nut. Install Retainer Tool (C-91-53118A1) and torque to 200 ft. lbs. (27.6mkg). (Figure 3)

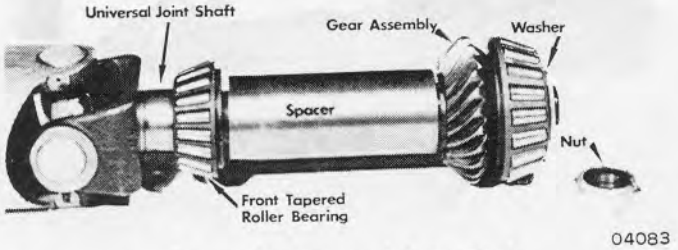


Figure 2. Universal Joint Shaft

4. Remove retainer tool and install bearing retainer with "O" ring. Torque to 30 ft. lbs. (4.14mkg). Rotate universal shaft as elastic stop nuts are tightened. If shaft binds, remove retainer and remove shims from retainer bearing cup, or, if shaft is loose or moves back and forth, add shims under retainer bearing cup. There must be some preload on the bearings before preceding with gear backlash.

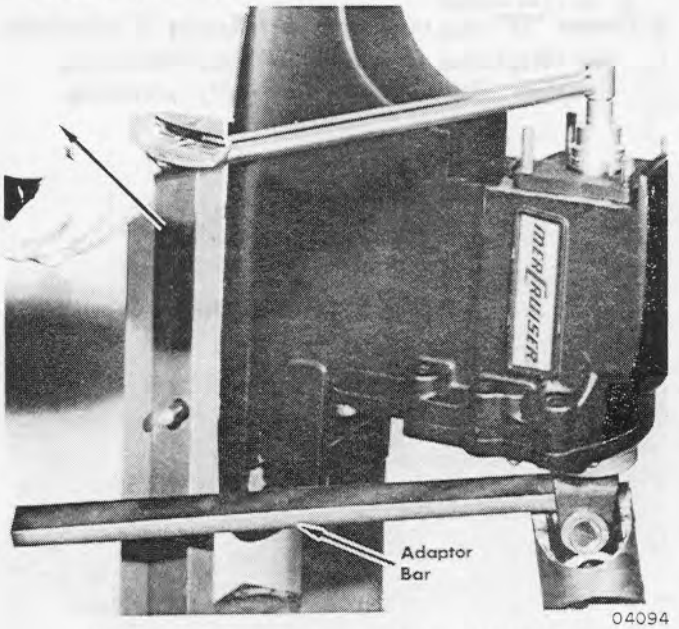


Figure 3. Torquing Universal Joint Shaft

CHECKING GEAR BACKLASH and BEARING PRELOAD

Measure gear backlash with Dial Indicator (.008" to .012") (.2 to .3mm) at 2¼" (57mm) radius. (Figure 4) To increase backlash, add shims under small bearing cup and remove an equal thickness of shims from under retainer bearing cup. To decrease backlash, remove shims from under small bearing cup and add shims of equal thickness under retainer bearing cup.

NOTE: When making any change in shim thickness, recheck clearance gap, preceding, after reinstallation of components.

1. Use Wrench Adaptor (C-91-48165), Torquing Tool (C-91-48606) with Torque Wrench Guide (C-91-52147) and torque wrench with reducers to determine drive shaft bearing preload. Torque valve on new bearings and gears should be 25 in. lbs. (4.44 kg/cm) plus-or-minus 5 in. lbs. (.89 kg/cm) at the driven gear. Torque value on original bearing and gears should be 15 in. lbs. (2.99 kg/cm) plus-or-minus 5 in. lbs. at the driven gear. The driven gear should turn smoothly with a constant torque value. (Figure 5) Add shims from under retainer bearing cup to increase preload. Remove shims from under retainer bearing cup to decrease preload.
2. Reinstall bearing retainer with "O" ring, torque nuts to 30 ft. lbs. (4.14mkg) and again check preload preceding.

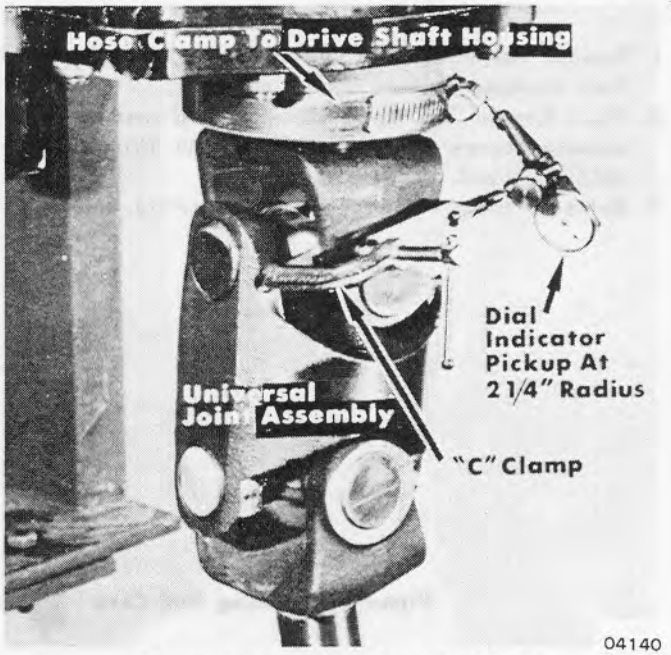


Figure 4. Measuring Gear Backlash

FRONT COVER and VALVE REASSEMBLY

1. Place front cover with a new gasket and oil seal in position, lip to drive shaft housing, then spring, valve and quadring as cover is placed on drive housing.
2. Tighten screws to 30 ft. lbs. (4.14mkg) and nuts to 20 ft. lbs. (27.6mkg).
3. Cement "O" ring to cover with Adhesive (C-92-36340).

See "Replacing Gear Housing" and "Removing Complete Drive Shaft Housing", preceding.

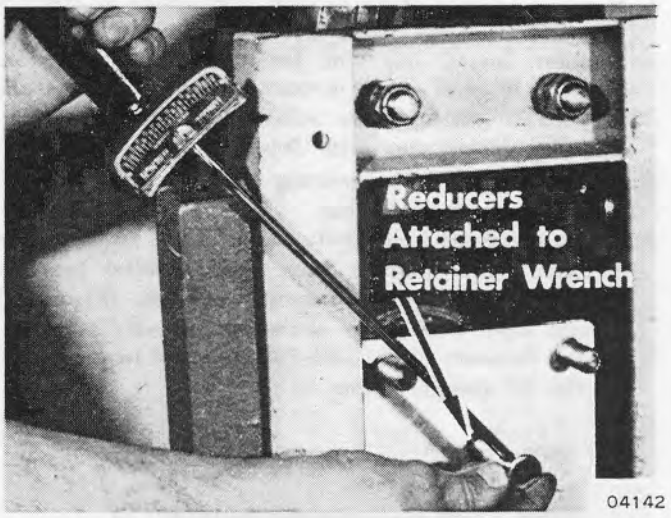


Figure 5. Torquing Driven Gear

GIMBAL HOUSING and GIMBAL RING DISASSEMBLY

1. Remove gimbal housing and transom plate from boat by reversing installation procedures outlined in "Installation Manual" (C-90-48375).
   NOTE: Remove oil hose at bell housing to drain gear lubricant from reservoir or, when changing bellows or bell housing, plug oil hose to retain gear lubricant in reservoir.
2. Remove hinge pins with 5/8 allen wrench. (Figure 1) Loosen bellows clamp and remove bellows.
3. Remove oil hoses, valve and guide assemblies.
4. Remove cotter pin to allow removal of lower swivel pin. Remove Synthane bushing from gimbal ring assembly, if necessary.
   NOTE: Remove old epoxy before installing new bushing with Epoxy Sealer (C-92-33749), following instructions in kit.

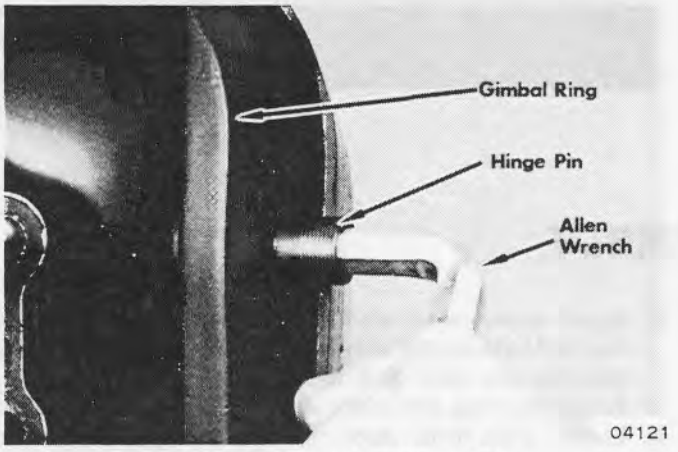


Figure 1. Removing Hinge Pin

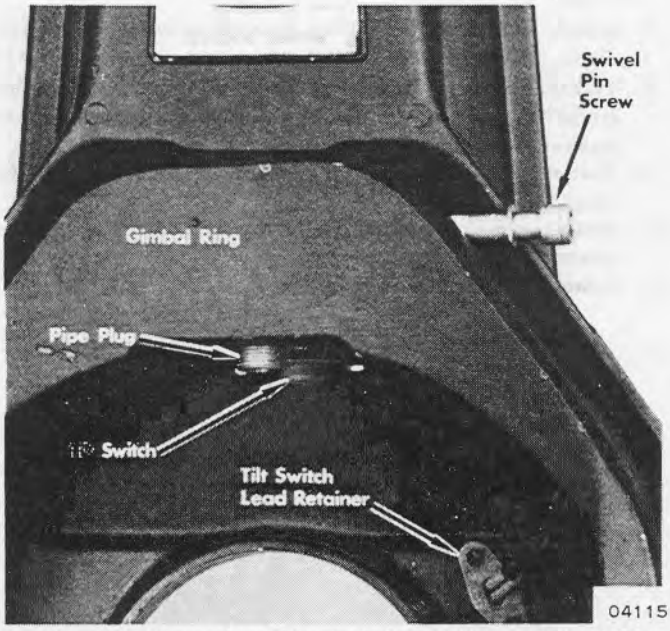


Figure 2. Removing Tilt Switch and Upper Swivel Pin

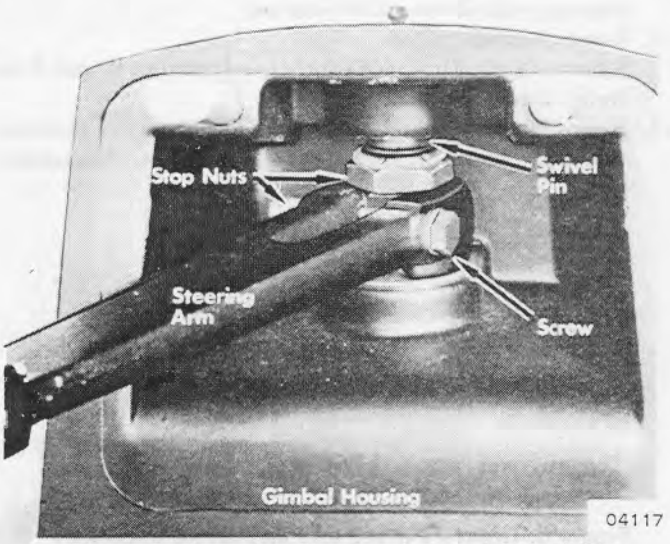


Figure 3. Removing Steering Arm and Swivel Pin

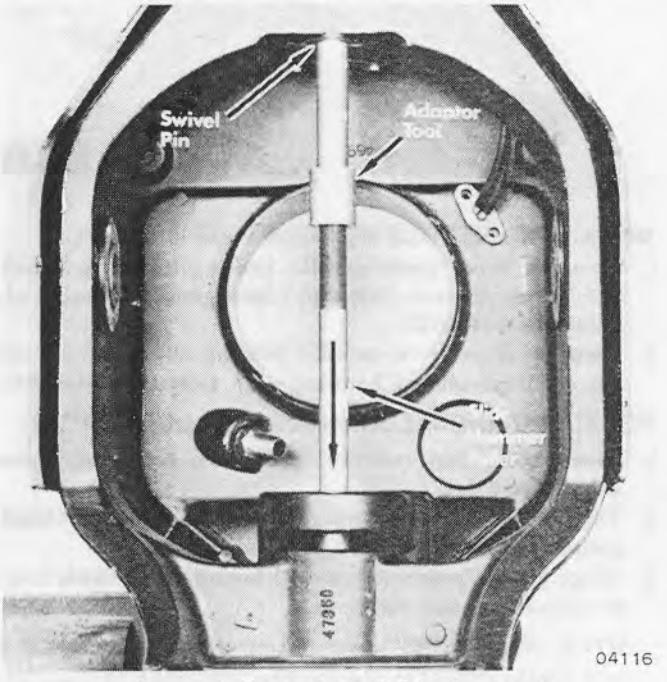


Figure 4. Upper Swivel Pin Removed

5. Remove switch actuating spring, then pipe plug from upper swivel pin. Trim limit switch can be removed for repair, if necessary.
6. Remove screw that holds swivel pin in position on gimbal ring. (Figure 2) Remove steering arm elastic stop nut and screw from swivel pin. (Figure 3) Large nut cannot be removed from swivel pin until it is removed.
7. Remove upper swivel pin with Slide Hammer Puller (C-91-34569A1) and Adaptor Tool (C-91-48653) thru lower swivel pin hole. (Figure 4)

8. Remove grease fitting from top of gimbal housing (Figure 5) and remove upper needle bearing and seal with long thin drift. NOTE that they will be damaged in removal.
9. Press lower needle bearings and oil seals from gimbal housing with Driver (C-91-48644).
10. Remove anodic plate.
11. Remove hydraulic accessories, as required, and Ride-Guide attaching parts.
12. Remove phillips head screws to remove oil reservoir cover and press oil level gauge from cover, if necessary.

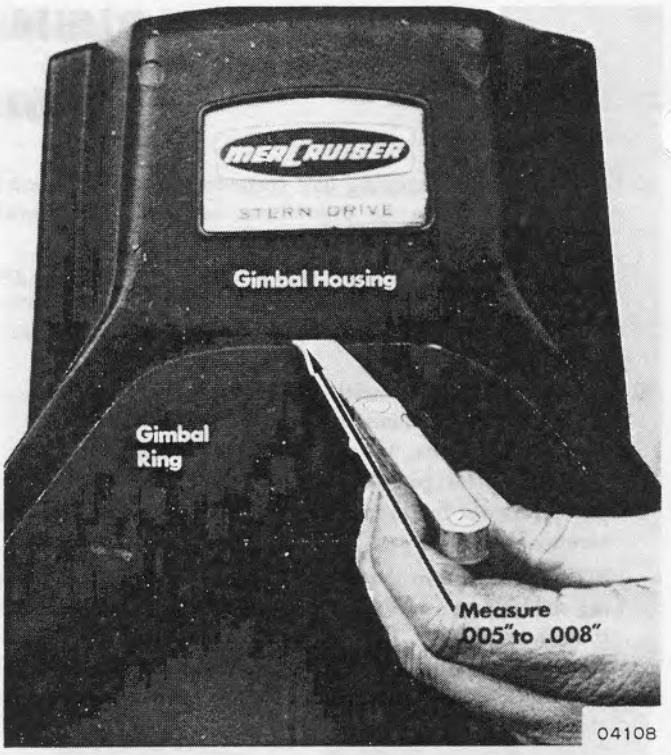


Figure 5. Grease Fitting and Measuring Clearance

REASSEMBLY

INSTALLING NEEDLE BEARINGS and OIL SEALS

1. Press or drive upper needle bearing with upper small and large oil seals (lips up) into gimbal housing with Driver (C-91-48642).
2. Press or drive lower needle bearing and lower oil seal (lip up) into gimbal housing with Driver (C-91-48644).

INSTALLING GIMBAL RING and TRIM LIMIT SWITCH

1. Install trim limit switch, spacer and retaining plate into gimbal ring.
2. Thread switch leads into gimbal housing and install switch lead retainer. (Figure 2)
3. Align gimbal ring with gimbal housing and install lower swivel pin and cotter pin.

NOTE: Remove old epoxy when installing new bushing with Epoxy Sealer (C-92-33749), following instructions in kit.

4. Install upper swivel shaft thru washers between gimbal ring and housing and under steering arm, placing elastic stop nut over shaft as it is assembled.
5. Install steering arm screw and nut, but do not tighten.
6. Install allen head screw, located at upper starboard side of gimbal ring and torque to 20 ft. lbs. (2.76mkg). (Figure 2)
7. Install allen head pipe plug, located in bottom of swivel shaft.
8. Tighten elastic stop nut on swivel pin, pulling up on gimbal ring to obtain .005 to .008 clearance between washer and gimbal ring. (Figure 5)
9. Torque steering arm screw and nut to 30 ft. lbs. (4.14-mkg).
10. Install grease fitting which is located on top of gimbal housing.
11. Install switch actuating lever.

BELL HOUSING INSTALLATION

1. Before installing universal joint bellows, clean outside diameter of bellows mounting flanges of gimbal housing and bell housing with a wire brush or sandpaper and wipe outside diameter of bellows mounting flanges with lacquer thinner. Apply Bellows Adhesive (C-92-36340A1) to inside diameter of each end of bellows.

WARNING: Bellows Adhesive contains TOLUOL. Avoid constant contact with skin or continued breathing of vapor. Keep away from children. Flammable -- DO NOT USE NEAR FIRE OR FLAME.

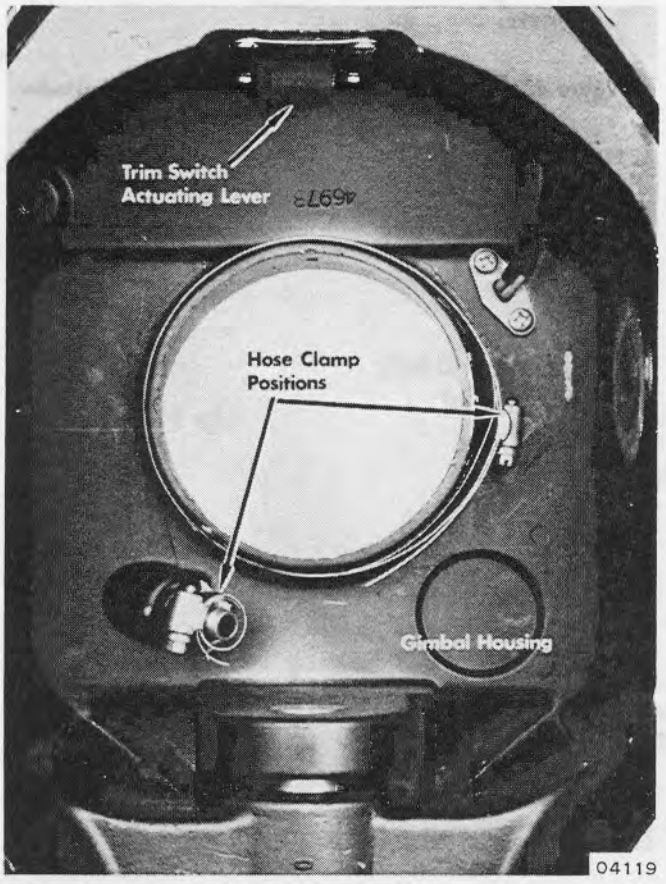


Figure 1. Hose Clamp Positions

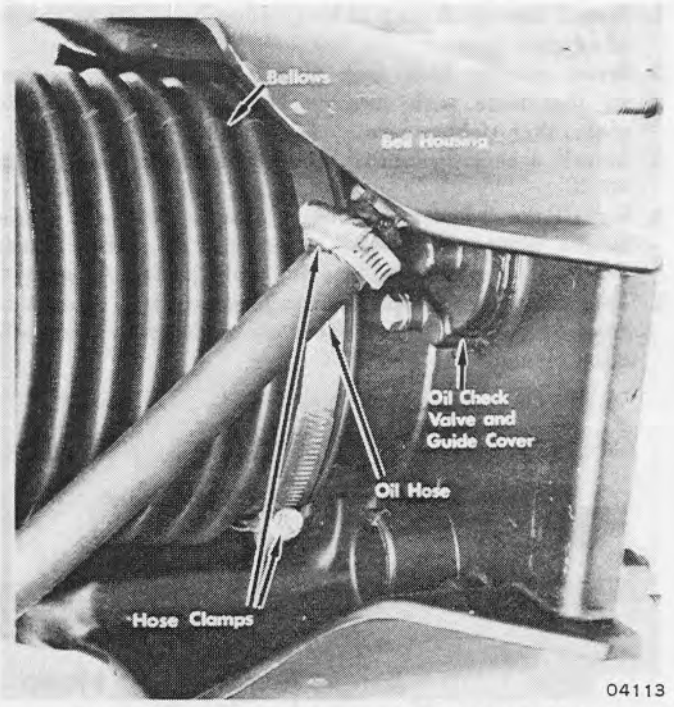


Figure 2. Bell Housing Component Positions

Allow adhesive to dry 5 to 10 minutes, or until no longer tacky, before installing bellows. In cold weather, heat bellows to room temperature with heat lamp or large electric light bulb to make more pliable for easier installation.

2. Install bellows with hose clamps on gimbal housing. (Figure 1)
3. Reassemble oil check valve and guide with new quad-ring and gaskets and install in bell housing.
4. Place spacer washers over hinge pin bushings and place bell housing into gimbal ring and in bellows.
5. Install hinge pins with Loctite (C-92-32609-1) on screw threads and tighten to 75 ft. lbs. (10.4mkg) torque.
6. Install oil hose between fittings on valve assembly and gimbal housing, tightening hose clamps securely. (Figure 2)
7. Check universal joint bellows carefully for kinks or uneven folds.
8. Cement "O" ring into bell housing bore with Bellows Adhesive (C-92-36340A1).

HYDRAULIC HOSES and CONNECTORS

INSTALLATION

1. Install straight fitting of long hydraulic hoses to center of adaptor body.
2. Insert adaptor body into gimbal housing with gasket so that hose with straight fitting is toward anodic plate, then tighten nuts.
3. Install 4 short hydraulic hoses to adaptor body. (Figure 3)
4. Install the 2 hydraulic hoses, that are closest to the anodic plate, to "down" ports on trim cylinders and the remaining hoses to the "up" ports. (Figure 4)
5. This completes gimbal housing reassembly. Reinstall drive unit and trim cylinders as outlined in "Installation Manual" (C-90-48375).

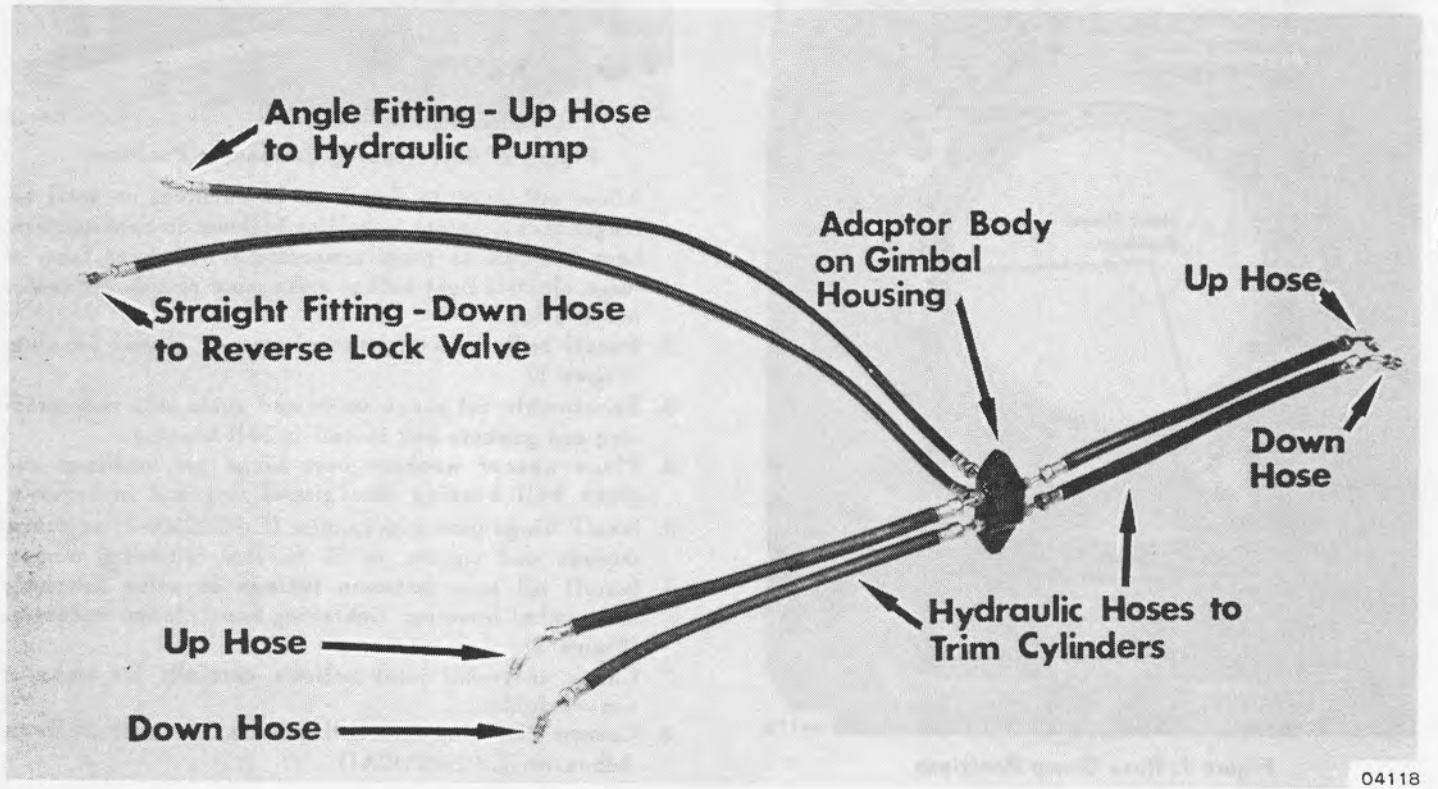


Figure 3. Hydraulic Hose Arrangement

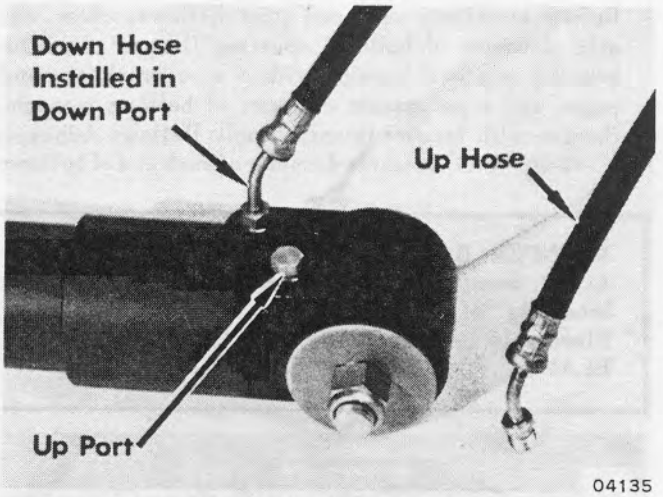


Figure 4. Installing Hydraulic Hoses to Trim Cylinder

SECTION 6 - DRIVE SYSTEMS

MERCRUISER

PART E - DIRECT DRIVE TRANSMISSION

MERCURY MARINE

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STERN DRIVE DIRECT DRIVE TRANSMISSION SERIES 71 and 72

DESCRIPTION

The transmission consists of a planetary gear set, a forward clutch, a reverse clutch, an oil pump and a pressure regulator and rotary control valve. All are contained in a cast iron housing (along with necessary shafts and connectors) to provide forward, reverse and neutral operation.

A direct drive ratio is used for all forward operation. In reverse, speed of the output shaft is equal to input shaft speed, but in the opposite direction. Helical gearing is used to provide operation more quiet than can be obtained with spur gearing.

Shifting is accomplished by fore and aft movement of the shift lever. This movement rotates control valve and directs oil under controlled pressure to required channels.

Oil pressure is provided by the crescent type pump and drive gear which is keyed to the drive shaft. Pump operates at transmission input speed to provide screened oil to the pressure regulator.

From the regulator valve, oil is directed through proper circuits to bushings and anti-friction bearings which require lubrication. A flow of lubricant is present at the required parts whenever the front pump is turning, and it should be noted that supply is positive in forward, neutral and reverse conditions.

The unit has seals to prevent escape of oil.

Both input and output shafts are coaxial, with input shaft splined for installation of a drive damper, and output shaft splined for connecting to the stern drive unit.

PRECAUTIONS

1. Oil cooler must be properly connected to transmission before engine is cranked or started. Failure to properly connect oil cooler will cause forward clutch piston to blow out from over-pressurization.
2. Change oil and clean oil screen once each season.
3. Check oil level at operating temperature.
4. Use clean containers for handling transmission fluid.
5. Fill transmission prior to starting engine.
6. Check oil level immediately after engine is shut off.
7. Use recommended automatic transmission fluids Type "A" Suffix "A" or new Dexron fluid.
8. Flush cooler and cooler lines after a transmission failure and prior to installing a new or rebuilt transmission.
9. Check engine alignment each time a transmission is replaced in boat.
10. Check shift linkage adjustment to insure that transmission shift lever is being positioned so that spring-loaded ball enters chamfered hole inside of shift lever in each selected position.
11. Check oil pressure and temperature when transmission functions indicate that a problem exists.
12. Always check pump hand of rotation prior to assembling transmission to engine to ensure that pump is properly indexed for engine rotation.
13. Except in emergency, never shift at engine speeds above 1000 RPM.
14. Never remove oil cooler lines or use smaller than recommended 13/32" diameter cooler lines when operating transmission.
15. Do not permit propeller shaft to rotate when transmission is inoperative. Propeller shaft rotation could be caused by towing, sailing or operation of second engine which could move the boat through the water and cause propeller to "windmill."
16. Ribbon dope (a thread sealant) must be used on hydraulic connections. when hydraulic lines are installed, to prevent hydraulic fluid from leaking.

LUBRICATION RECOMMENDATIONS

The properties of the oil used in the transmission are extremely important to the proper function of the hydraulic system. Therefore, it is necessary that the recommended oil, automatic transmission fluid (ATF), Type "A", Suffix "A", be used.

PROCEDURE for FILLING TRANSMISSION with OIL

When filling transmission, add oil until it reaches full mark on dipstick. Quantity of oil depends upon angle of installation, but information to serve as a guide on possible amount needed may be found in chart following. Unit should be turned over at engine idle speed for a short time in order to fill all circuits, including cooler and cooler piping.

NOTE: Be sure that cooler is properly installed and that transmission contains oil before cranking or starting engine.

PROCEDURE for CHECKING OIL LEVEL

Oil level should be checked immediately after stopping engine, and sufficient oil added to again bring transmission oil level to full mark on dipstick assembly. Dipstick assembly need not be threaded into case to determine oil level. Merely insert into case until cap or plug rests on surface surrounding oil filler hole.

Transmission should be checked periodically to assure proper oil level, and oil should be added if necessary.

CHANGING OIL

It is recommended that transmission oil be changed once each season. After draining oil from unit, thoroughly clean the removable oil screen before refilling transmission with recommended oil (ATF), Type "A", Suffix "A".

NOTE: Oil capacity does not include capacity needed for transmission cooler and oil lines, which may require an amount greater than in table on right.

OIL CAPACITY

Transmission Model	Transmission Oil Capacity (Quarts)	
	Level	15° Inclined
AS 1-71C	1.8	1.3
AS 1-72C	2.1	1.7

KEY to TROUBLESHOOTING CHART on PAGE 6E-3

1. *Loose bolts - tighten.*
2. *Damaged gasket.*
3. *Damaged oil seal.*
4. *Oil line fittings loose - tighten.*
5. *Case leaks, porosity - replace.*
6. *Oil filler plug or cap leaks - replace or tighten.*
7. *Damaged control valve "O" ring.*
8. *Foreign material on mating surfaces - clean.*
9. *Damaged oil cooler, water and oil mixing - replace.*
10. *No oil - check at once.*
11. *Pump improperly located for engine rotation - locate correctly.*
12. *Sheared drive key - replace.*
13. *Faulty oil gauge - clean or replace, bleed air from gauge line.*
14. *Dirty oil screen - clean or replace.*
15. *Low oil level - add oil to proper level.*
16. *Regulator valve stuck - replace valve.*
17. *Worn oil pump - replace if necessary.*
18. *Regulator spring weight low - replace valve.*
19. *High oil level - drain oil to proper level.*
20. *Low water level in cooling system.*
21. *Dirty oil cooler - clean.*
22. *Worn or misaligned bushings in transmission case - replace.*
23. *Worn or damaged clutch piston oil seals.*
24. *Worn or damaged clutch sealing rings.*
25. *Clutch improperly assembled.*
26. *Damaged or broken belleville spring.*
27. *Worn or damaged clutch plate(s) - replace.*
28. *Damaged or broken clutch springs.*
29. *Regulator valve not notched - replace valve.*
30. *Inadequate torque on output shaft nut - tighten.*
31. *Nicks on gears - remove with stone.*
32. *Excessive runout between engine housing and crankshaft.*
33. *Damaged damper assembly parts - replace.*
34. *Body - fit bolts not used in mounting holes.*
35. *Control linkage improperly adjusted.*
36. *Control lever and poppet ball corroded - clean and lubricate.*
37. *Control linkage interference - check.*
38. *Wrong oil used in transmission - change.*
39. *Cold oil.*
40. *Planetary gear failure - replace or repair if necessary.*

TROUBLESHOOTING CHART

COMPLAINTS and SYMPTOMS	REMEDY	
	TRANSMISSION in BOAT	TRANSMISSION REMOVED
Internal and External Leaks		
Oil leaks at pump		1 2 3 8
Oil on exterior of transmission	1 4 6 7	2 5 8
Oil leaks at rear bearing retainer	1 2* 3* 8	
Water in transmission oil or oil in cooling water	9	
Transmission Malfunctions in All Ranges		
No oil pressure	10	11 12
Low oil pressure	13 14 15 16 18	17
High oil temperature	9 15 19 20 21	40
Failure of reduction gear		40
Transmission Malfunctions in Forward Range		
Low oil pressure	13 14 15 16 18	17
Forward clutch engages improperly	35	12 22 23 24 25 26 27
Forward clutch drags	35	25 26 27
Reduction unit failure		40
Transmission Malfunctions in Reverse Range		
Low oil pressure	13 14 15 16 18	17
Reverse clutch engages improperly	35	23 25 27 28
Reverse clutch drags	35	25 27 28
Reverse gear set failure		40
Reduction gear set failure		40
Transmission Malfunctions in Neutral		
Output shaft drags excessively in forward rotation	35	25 26 27
Output shaft drags excessively in reverse rotation	35	25 27 28 40
Miscellaneous Transmission Problems		
Regulator valve buzz	29	
Gear noise-forward	30	31
Gear noise reverse	30	31 40
Pump noise	15	17 31
Damper noise or failure		32 33 34
Shifts hard	16 37	7 35 36
High oil pressures	16 38 39	

**If installation allows access, otherwise remove transmission.*

71 and 72 SERIES TRANSMISSION (STERN DRIVE)

1 - Transmission Assembly
2 - Bushing Kit
3 - Breather
4 - Spring, poppet
5 - Ball, detent
6 - Dipstick
7 - Spring and Valve Assembly
8 - "O" Ring
9 - Cover, valve
10 - Gasket
11 - Screw
12 - Lockwasher
13 - Strainer, oil
14 - Tube, oil strainer
15 - Bushing
16 - Baffle, oil
17 - Gasket
18 - Ring, snap
19 - Washer, thrust
20 - Pinion Gear and Shaft Assembly
21 - Washer, thrust
22 - Key
23 - Drive Gear and Shaft Assembly
24 - Gear, forward clutch
25 - Ring, snap
26 - Key
27 - Ring, sealing
28 - Gear, ring
29 - Plate, pressure
30 - Plate, clutch (outer) bronze
31 - Plate, clutch (inner) steel
32 - Plate, pressure
33 - Spring, clutch plates
34 - Ring, sealing
35 - Ring, forward clutch piston
36 - Piston, forward clutch
37 - "O" Ring
38 - Cylinder, forward clutch
39 - Ball Bearing
40 - Ring, snap - ball bearing ret.
41 - Ring, snap - ball bearing ret.
42 - Washer, thrust
43 - Ring, snap
44 - Plate, reverse clutch
45 - Plate, reverse clutch
46 - Pin, dowel
47 - Spring
48 - Plate, pressure
49 - Ring, sealing
50 - Piston, reverse clutch
51 - "O" Ring
52 - Adaptor
53 - Roller Bearing
54 - Screw
55 - Gasket
56 - Front Pump Assembly
57 - Oil Seal
58 - Screw

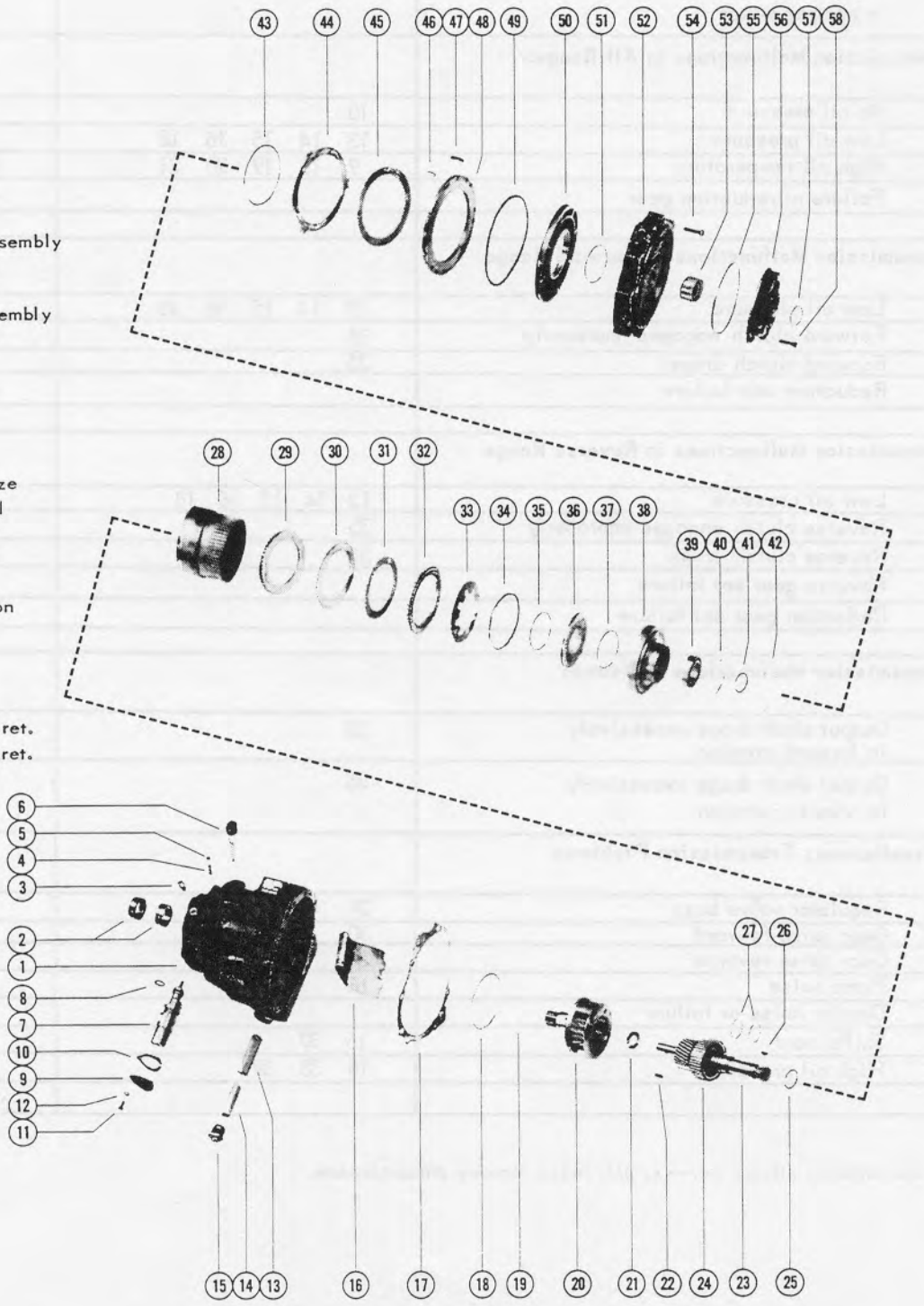

Figure 1. Transmission, Exploded View

REMOVAL

NOTE: Engine must be removed to remove transmission. Refer to "Removal - Installation - Alignment", Section 2.

1. Remove shift linkage and oil lines.
2. Remove rear engine mounts from transmission.
3. Remove 6 bolts which attach transmission to flywheel housing.
4. Remove transmission.

DISASSEMBLY

NOTE: Some tools are not available and must be fabricated. Refer to "Tools" at the end of this PART. Tear down procedure should not begin until transmission exterior and work area have been thoroughly cleaned.

1. Remove oil filler plug, located below shift lever on rear side of transmission case.
2. If space permits, place container with approximately 2 quart capacity under transmission, located as shown in Figure 2. Unscrew drain plug and cooler return tube assembly. Reach into opening with a suitable tool and remove strainer assembly. (Figure 2) Allow oil to drain into pan.
3. Remove engine coupling guide spring.
4. Remove 8 cap screws and lockwashers and remove tail stock housing and gasket.

NOTE: Tap housing with mallet to break loose. See Step 61 for tail stock service.

5. Tap engine coupling assembly with mallet to remove.

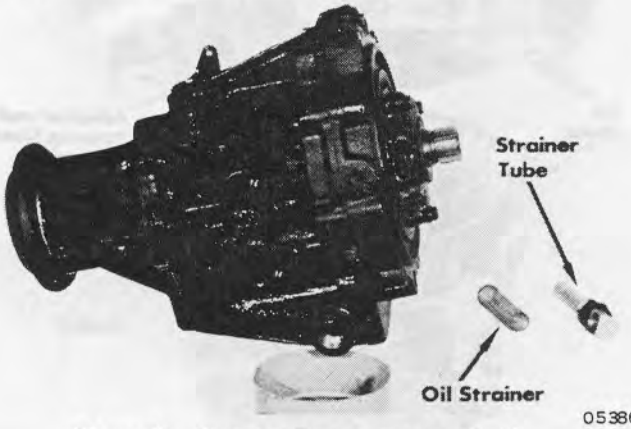

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Figure 2. Draining Transmission Fluid

NOTE: Bearing may be assembled upside-down, with groove not useable or no groove at all.

6. Tap shaft to remove shaft and bearing. (Figure 3)
7. Using Snap Ring Pliers (J5586), remove ring retainer, which holds bearing on shaft, and press shaft thru bearing.
8. Remove nut, lockwasher and flat washer from shift lever and remove shift lever.

> **CAUTION: Remove shift lever carefully; DO NOT lose indent ball and spring.**

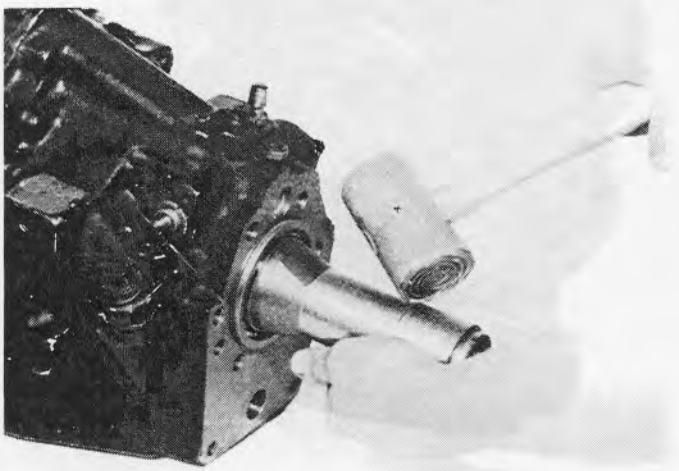

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Figure 3. Removing Bearing and Shaft from Case

9. Remove 3 screws and lockwashers, valve cover and gasket. Tap out valve assembly. (Figure 4)
10. Remove 4 cap screws from oil pump. Apply tape around input shaft splines.

NOTE: Note location of arrow on pump. Being careful not to damage seal lip, lift pump assembly squarely over protruding input shaft.

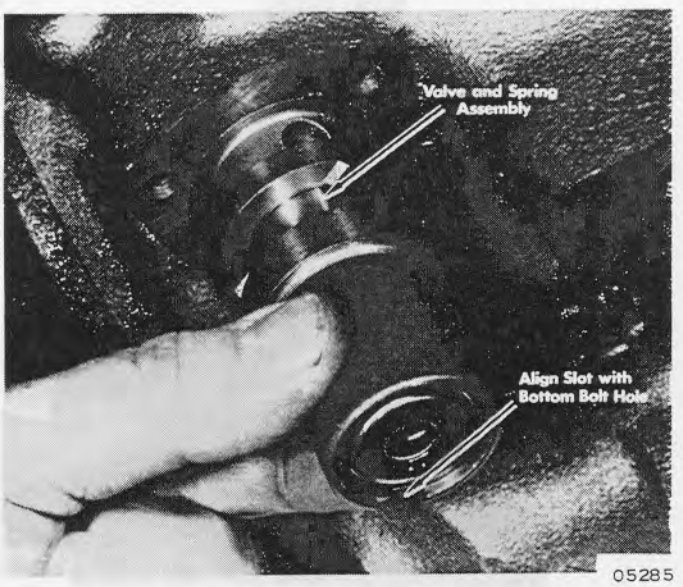

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Figure 4. Valve Removal

11. Remove pump drive gear, front pump gasket and woodruff key. (Figure 5)
12. Mark gears to identify proper relocation of gear faces during reassembly.

NOTE: Pump and drive gear are a matched set and are not sold separately.

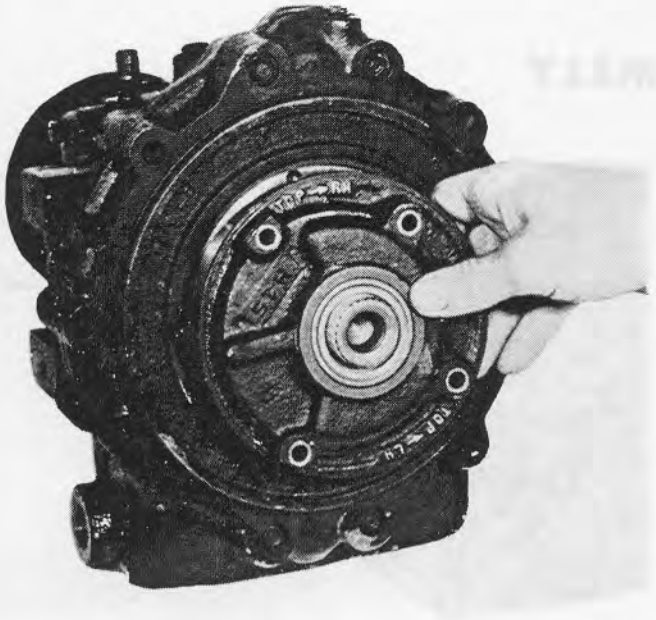

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Figure 5. Removing Oil Pump

13. To replace oil seal in pump housing, place pump housing squarely on arbor press table. Apply Loctite to outside diameter of seal and press seal into housing with Tool J-22922 until front face of seal is flush with front face of pump housing. (Figure 6)

NOTE: Wipe away any excess Loctite.

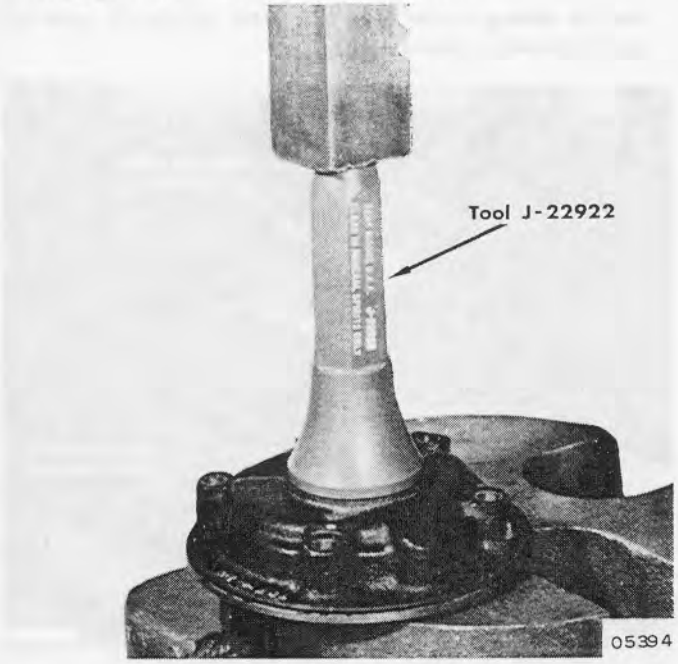

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Figure 6. Oil Seal Installation

14. Remove 4 cap screws (12 point head). (Figure 7) Lift adaptor and reverse clutch piston. (Figure 8) If necessary, tap adaptor with a soft hammer to remove.

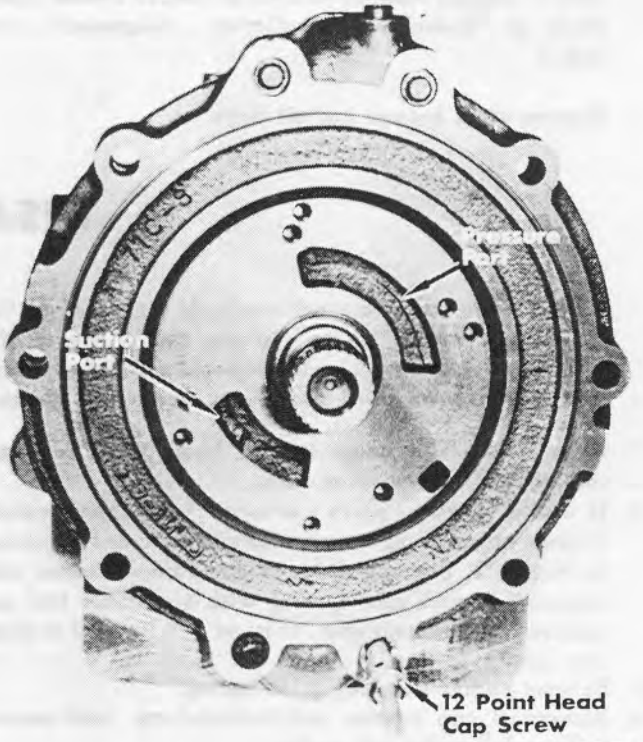

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Figure 7. Removing Adaptor

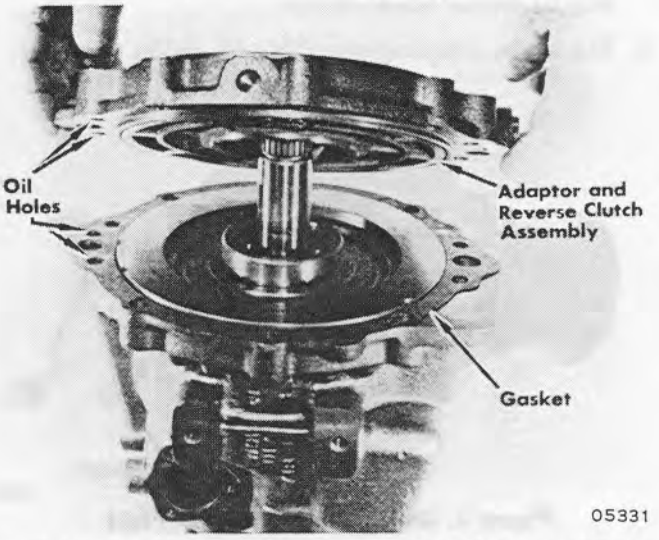

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Figure 8. Removing Adaptor and Reverse Clutch Assembly

> CAUTION: Reverse clutch pressure plate may stick momentarily to reverse clutch piston. To avoid damage, prevent pressure plate from dropping.

15. Force compressed air into reverse clutch cavity while holding piston, as shown in Figure 9, and piston will pop out of reverse clutch cavity.
16. Remove sealing rings as shown in Figures 10 and 11.

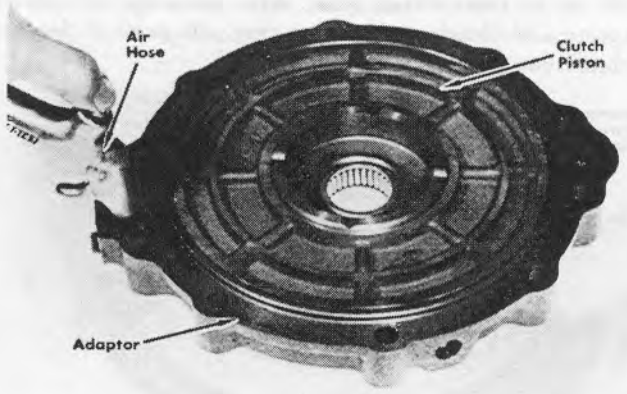

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Figure 9. Disassembling Reverse Clutch Piston

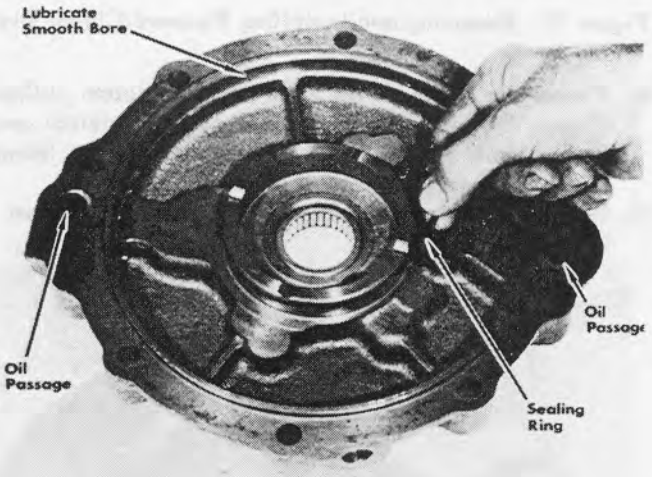

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Figure 10. Removing Sealing Ring

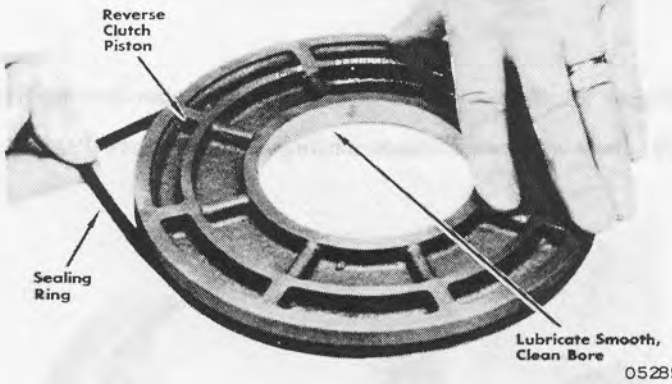

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Figure 11. Removing Outer Sealing Ring

17. Check needle bearing in adaptor for wear. Replace if worn, using tools.
18. Remove thrust washer (Item 42), clutch pressure plate (48), 12 pressure plate springs (47) and 3 dowel pins (46) (Figure 12) and reverse clutch pressure plates.
19. Grasp exposed front end of input gear and lift straight up. Drive gear and clutch assembly parts easily. Lift out of opening in front. (Figure 13)

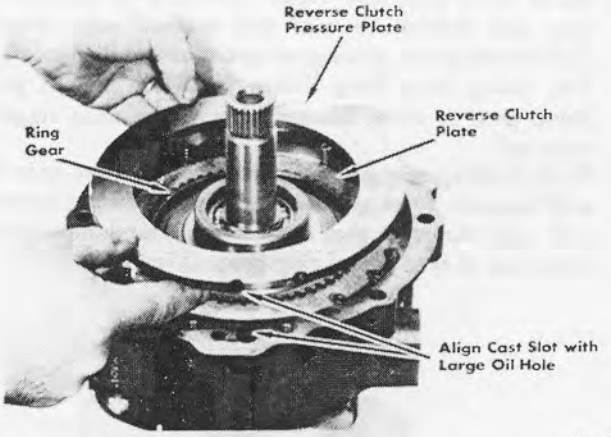

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Figure 12. Removing Reverse Clutch Pressure Plate

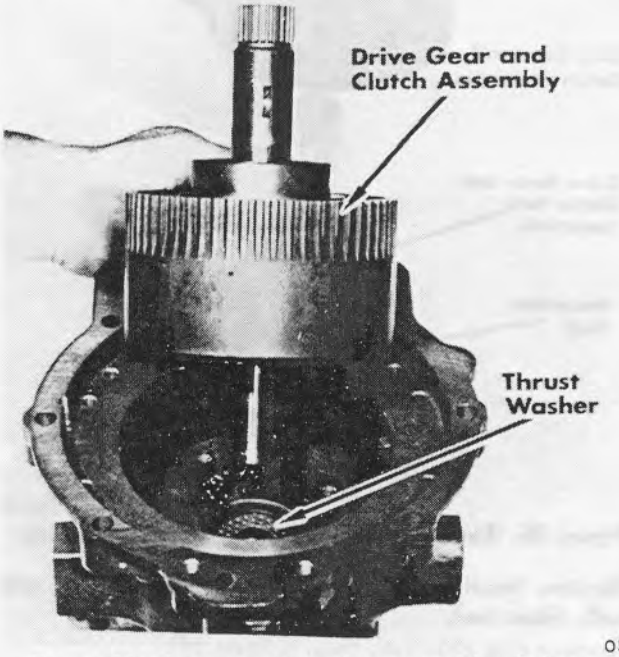

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Figure 13. Removing Drive Gear and Clutch Assembly

20. Remove thrust washer, located between drive gear and planetary carrier.

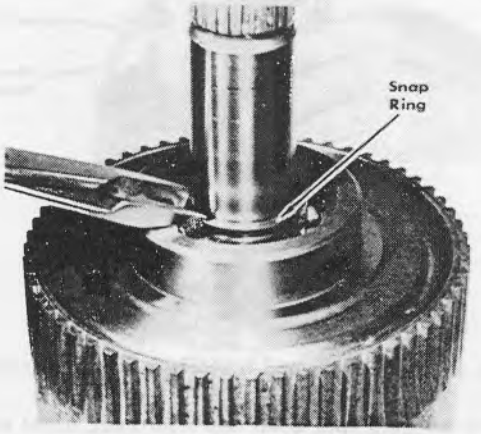

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Figure 14. Removing Snap Ring

21. Stand drive gear and clutch assembly in suitable fixture and remove internal and external snap rings at ball bearing from drive gear and clutch cylinder (Figure 14), using Snap Ring Pliers (J-5586). Do not permit drive gear to move forward after above snap rings are removed.
22. While holding ring gear, tap front end of drive gear with soft hammer. Drive gear and forward clutch hub assembly will pass thru ring gear and forward clutch assembly to come out of rear end of ring gear. (Figure 15)

05315

Figure 15. Removing Ring Gear and Clutch Assembly

23. Remove bearing from clutch cylinder by tapping with soft, blunt tool.
24. Remove ring gear snap ring. (Figure 16)

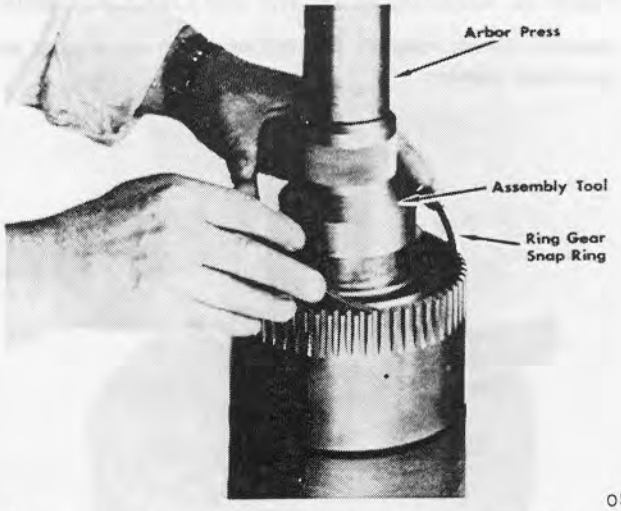

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Figure 16. Removing and Installing Ring Gear Snap Ring

25. While holding ring gear, tap with soft, blunt tool on exposed face of forward clutch cylinder inside of ring gear. Forward clutch cylinder will move forward to disassemble out of front of ring gear. After removing the clutch spring and clutch spring snap ring, all parts of forward clutch can be disassembled.

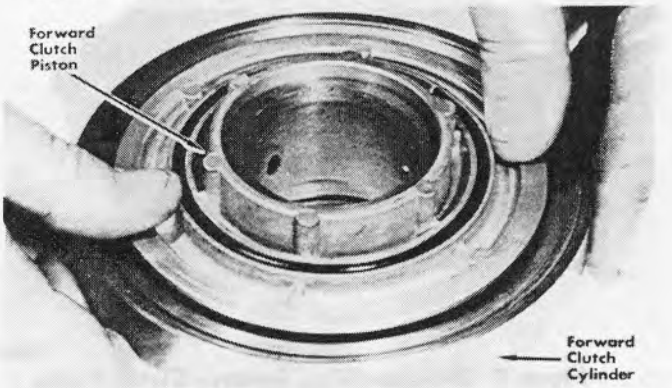

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Figure 17. Removing and Installing Forward Clutch Piston

26. Piston can be removed from forward clutch cylinder (Figure 17) by applying compressed air to clutch cavity through one of 3 holes in inside diameter of forward clutch cylinder, while other holes are blocked.
27. Remove forward clutch sealing rings, as shown in Figures 18 and 19.

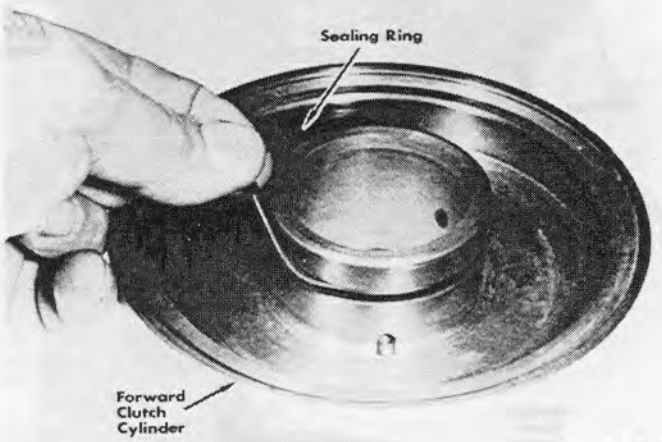

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Figure 18. Removing Forward Clutch Cylinder Sealing Ring

28. Remove forward clutch sealing rings. (Figure 19)

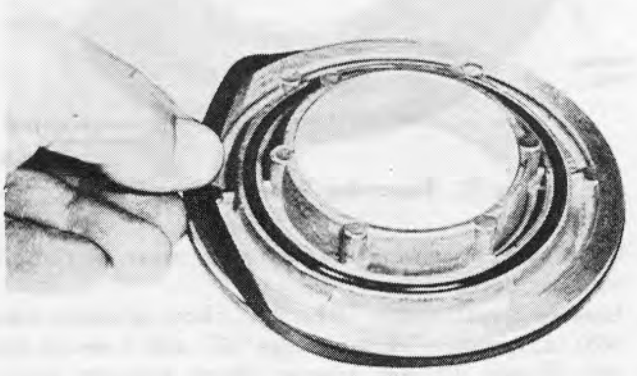

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Figure 19. Removing Forward Clutch Piston Sealing Ring

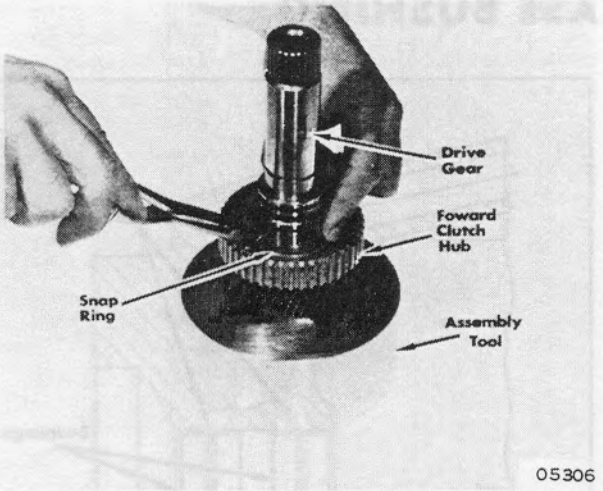


Figure 20. Removing Clutch Hub Snap Ring

29. Using Snap Ring Pliers (J-5586), remove snap ring from forward clutch hub and drive gear. (Figure 20)
30. If drive gear must be replaced, press clutch hub shaft out of drive gear. (Figure 21)
31. Remove pinion cage and output shaft by lifting out of transmission housing.
32. Remove thrust washer from pinion cage and output shaft.
33. Remove oil baffle from transmission housing by pressing down on baffle and pulling baffle out.

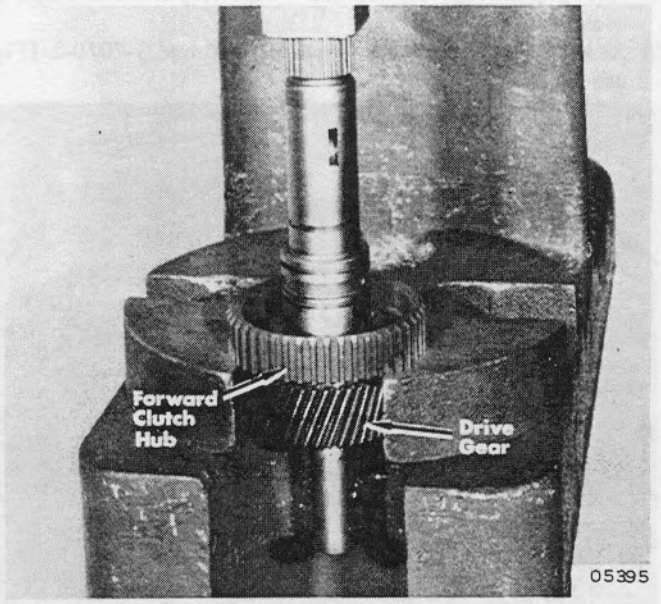


Figure 21. Pressing Clutch Hub Shaft from Drive Gear

TRANSMISSION CASE BUSHING

1. Check bushings for fit and wear. Replace bushings as required.
2. Remove bushings with Tools J-8466 and J-7079-2. (Figure 1)

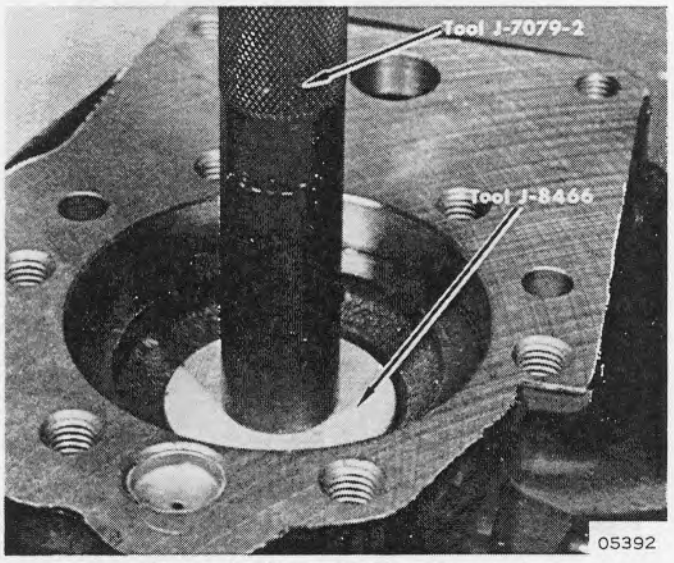


Figure 1. Case Bushing Removal

3. Check bore size. Bore should be 1.989" to 1.990". If bore exceeds this dimension, replace housing. (Fig. 2)
4. Coat inside of bore with Loctite Retaining Compound 35 (C-92-58254A1).
5. Install new bushing from Bushing Kit B-23-56572 with Tools J-8466 and J-7079-2. Bushings are pressed in from their respective ends.

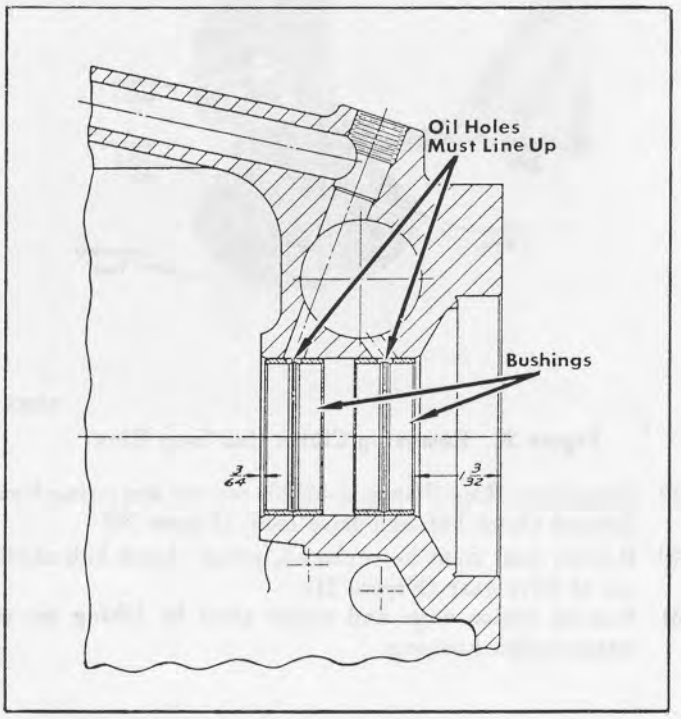


Figure 2. Case Bushing Installation

NOTE: Oil holes in bushings must line up with oil holes in case. Assemble each bushing in case bore from its respective end.

OUTPUT SHAFT BUSHING

1. Check bushings for fit and wear. Replace bushings as required.
2. Press bushings from output shaft with Tool C-91-58868. (Figure 3)
3. Coat inside of bore with Loctite Retaining Compound 35 (C-92-58254A1) and install new bushings from 2 Bushing Kits (B-23-56562) with Tool C-91-58868. Discard extra bushing.

NOTE: Oil holes in bushings must line up with oil holes in shaft.

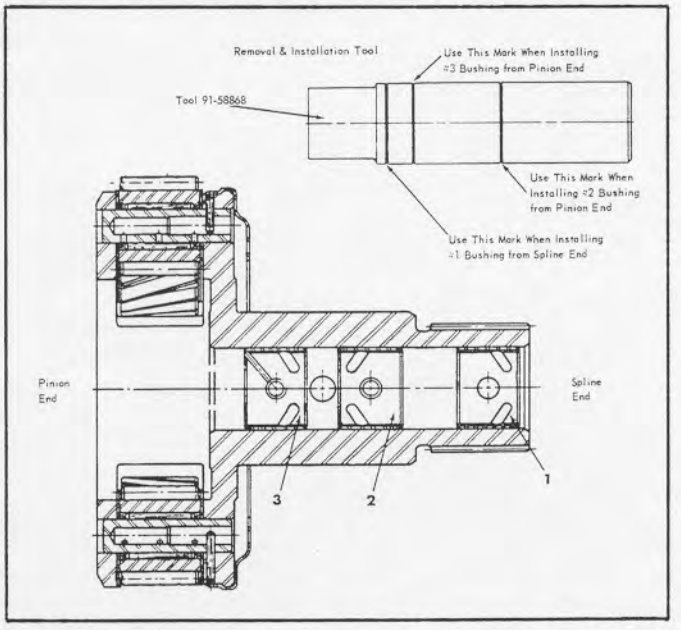


Figure 3. Shaft Bushing Installation

CLEANING and INSPECTION

1. Cleanliness is absolutely necessary during reassembly to ensure proper functioning of transmission. Transmission case passages always should have pipe plugs removed to allow for thorough cleaning. When available, use compressed air to dry parts before they are assembled. Do not wipe parts with rags to clean or dry them, as lint from the cloth may cause erratic valve action.
2. Inspect all parts for damage or wear. Replace defective parts.
3. All gaskets, oil seals and rubber sealing rings should be replaced, except in relatively new units. Judgement should be exercised as to need for replacing parts.
4. Oil seals and bearings are best installed by using an arbor press, suitable fixtures and tools to properly align parts being assembled. Hammering seals and bearings into position can severely damage parts.
5. Use automatic transmission fluid Type "A" Suffix "A" to lubricate parts as they are assembled. Petroleum jelly may be used on gaskets or other parts that must be held in position during assembly. All rubber parts will slide more freely if lubricated.
6. Tighten all bolts and screws evenly to recommended torque shown in Section 8.

REASSEMBLY

1. Place oil baffle inside transmission case with curved portion below cast spherical bosses in case, as shown in Figure 4.
2. Position front end of baffle so that center of baffle rests on top of boss at front center of transmission case, and the turned down corners of baffle are located below cast spherical bosses at front of transmission case. Snap baffle into position by lifting up on curved portion so that the 2 large holes are located firmly on spherical bosses at rear of transmission case.

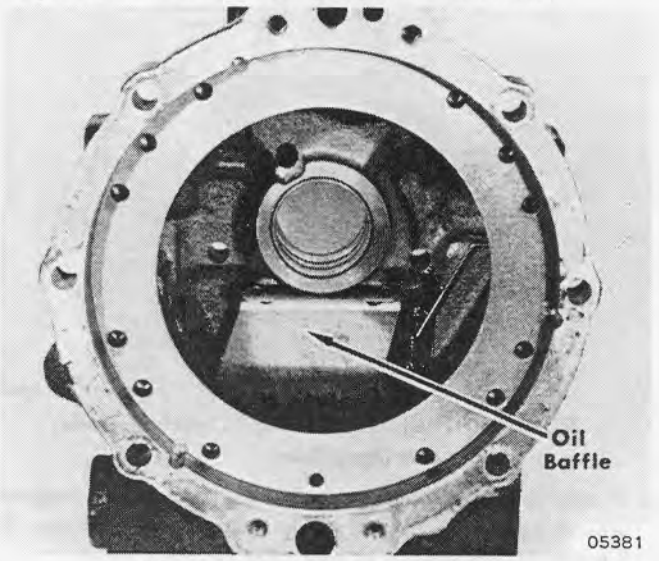


Figure 4. Installing Oil Baffle

3. Support transmission housing with wood support on output shaft end. Install thrust washer with tang in groove of housing.
4. Install pinion cage and output shaft assembly in transmission housing.
5. Place ring gear on a clean surface with external teeth up, as shown in Figure 5.
6. Remove all dirt and solid particles from shoulder inside gear formed by top of internal helical gear. (Figure 5)
7. With smoothly ground face in upward position, install clutch pressure plate (rear) in ring gear as shown in Figure 5. Assembly is complete when clutch pressure plate is firmly and squarely seated on shoulder at bottom of internal splines.

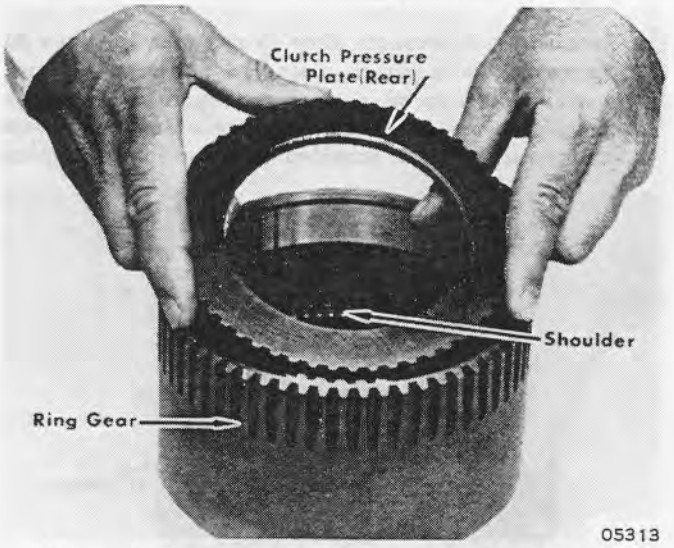


Figure 5. Installing Clutch Pressure Plate (Rear)

8. For Model 71C, lubricate 5 clutch inner plates and 4 outer clutch plates, arrange and assemble as shown in Figure 6.
   For Model 72C, lubricate 7 clutch inner plates and 6 center clutch plates.

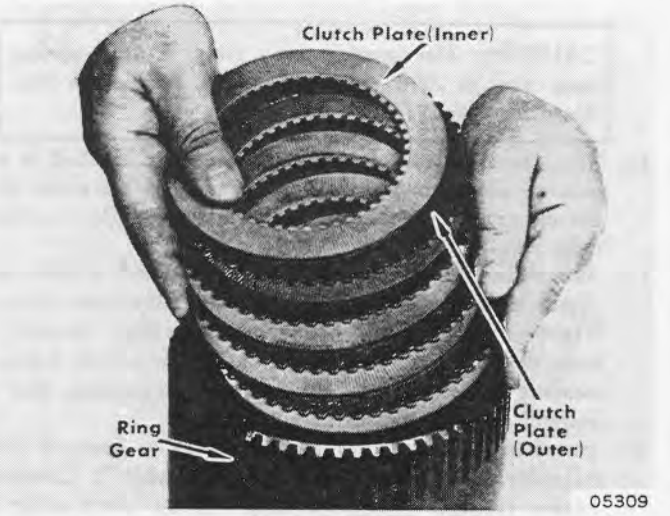


Figure 6. Installing Forward Clutch Plates

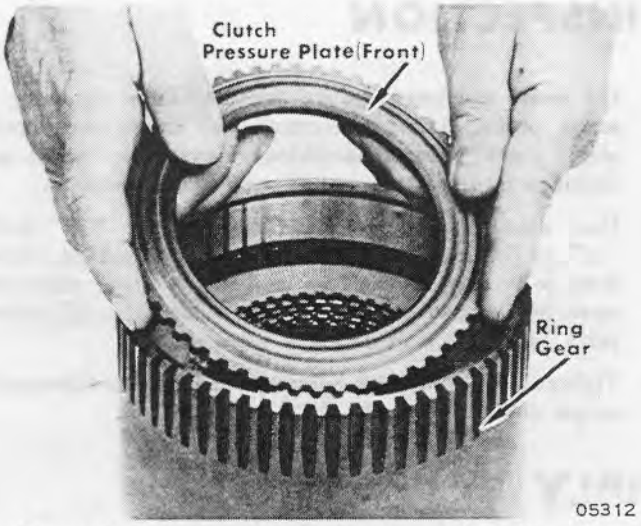


Figure 7. Installing Clutch Pressure Plate (Front)

9. Install clutch pressure plate (front) with flat face down in contact with clutch plate, as shown in Figure 7.
10. Install clutch spring snap ring. (Figure 8) Assembly is complete when snap ring is squarely and firmly seated on internal shoulder provided on top of internal splines.

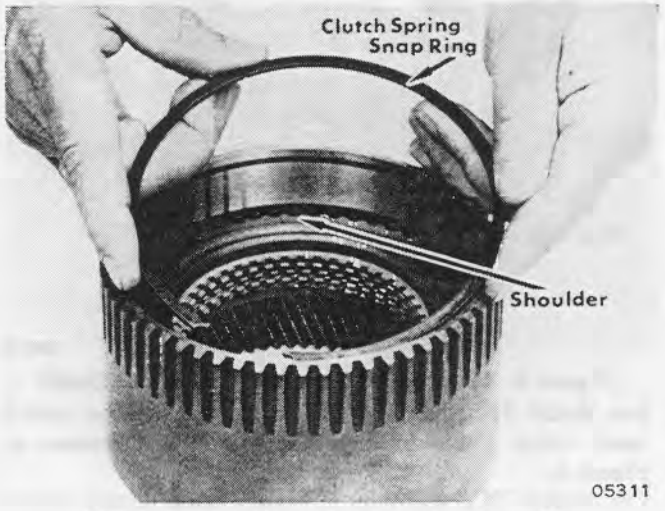


Figure 8. Installing Clutch Spring Snap Ring

CAUTION: Use proper snap ring. Clutch spring snap ring is .090" to .093" thick and has a free diameter of 5-19/32" + 1/16".

11. With concave side of clutch spring down, install in ring gear as shown in Figure 9. Assembly is complete when clutch spring is seated firmly and squarely on clutch snap ring.
12. Assemble clutch spring bearing ring and a lubricated clutch sealing ring on forward clutch piston as shown in Figure 19 in "Disassembly", preceding. Inspect inside diameter of forward clutch piston which contacts sealing ring. Remove all burrs or scratches and lubricate before assembly.
13. Install a well-lubricated sealing ring in forward clutch cylinder. (Figure 18 in "Disassembly") Lubricate entire forward clutch cylinder before continuing assembly.
14. After aligning assembled forward clutch piston squarely on assembled forward clutch cylinder, press clutch

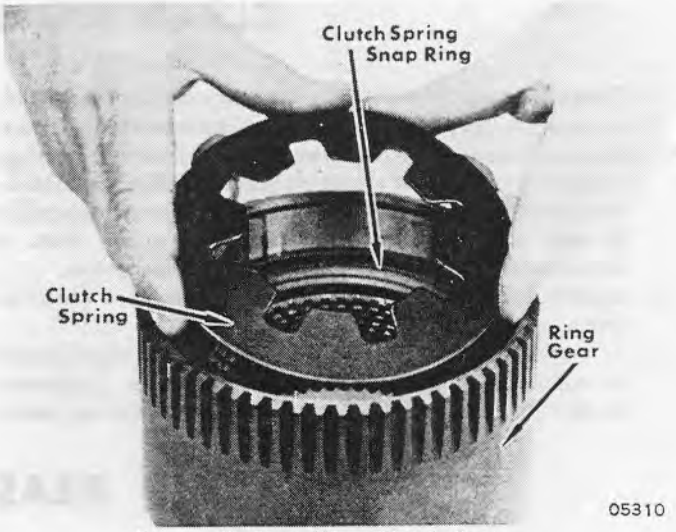


Figure 9. Installing Clutch Spring

piston into forward clutch cylinder. (Figure 10) This is a hand assembly and should not require pounding by hammer or pressing on arbor press. Assembly is complete when piston "bottoms" in forward clutch cylinder.

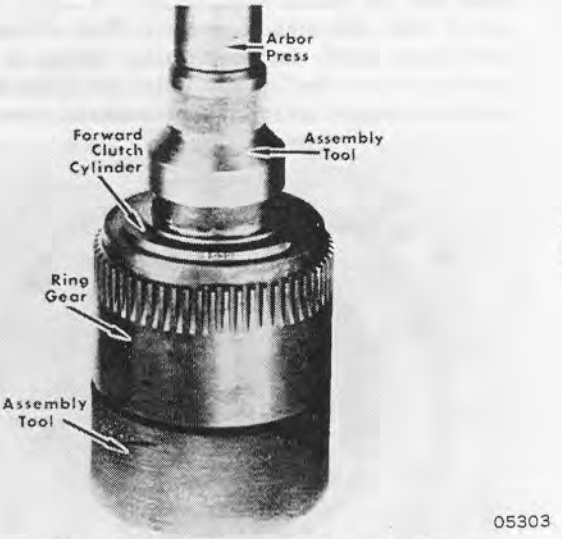


Figure 10. Pressing Forward Clutch Cylinder into Ring Gear

15. Place clutch plate assembly on a suitable support which has been placed on an arbor press. (Figure 11) Center clutch spring in ring gear.
16. Place clutch and shaft assembly into open top of clutch plate assembly. (Figure 11) Place a suitable assembly tool squarely on top of forward clutch cylinder and press down with arbor press until forward clutch cylinder is firmly seated on snap ring, and groove for snap ring is fully exposed. Check by looking into rear of ring gear to be sure that clutch bearing ring is properly assembled on forward clutch piston.
17. While maintaining load from arbor press, assemble ring gear snap ring. (Figure 16 in "Disassembly") Tap ring while in place to ensure full seating of ring in groove.

CAUTION: Use proper snap ring. Ring gear snap ring is .074" to .078" thick and has a free diameter of 5-7/8" + 1/16".

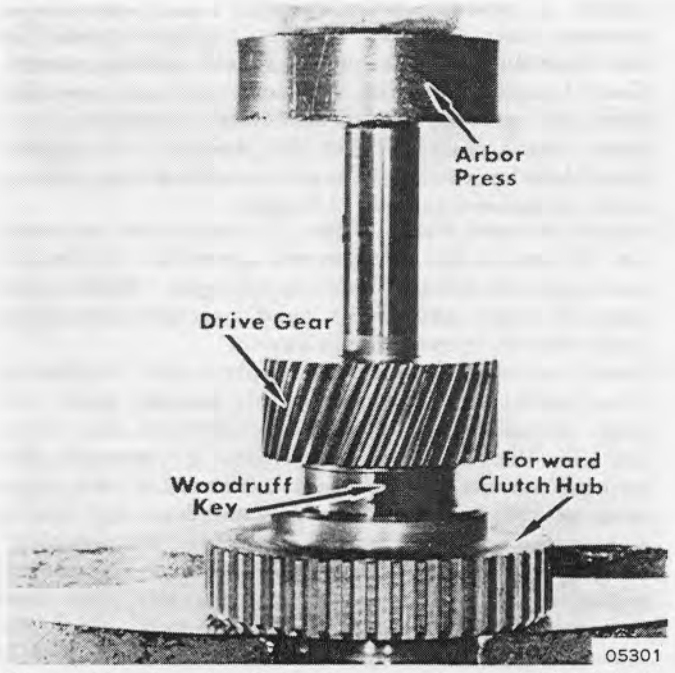


Figure 11. Pressing Drive Gear into Forward Clutch Hub

18. Place forward clutch hub on a suitable support placed on an arbor press in position shown in Figure 11. Assemble woodruff key in keyway provided on drive gear. (Figure 11) Lubricate outside diameter of drive gear on area which presses into forward clutch hub.
19. Install drive gear and woodruff key squarely into forward clutch hub, being careful to align key with mating keyway in forward clutch hub. (Figure 11) Press drive gear into forward clutch hub until gear "bottoms" on face of forward clutch hub, and groove for snap ring is fully uncovered.
20. Invert forward clutch assembly and install snap ring in groove provided. (Figure 11) Tap ring after assembly with suitable tool to ensure full seating in groove.
21. Install 2 forward clutch sealing rings in grooves provided on drive gear. (Figure 12) After installing rings in groove, hook ends and turn rings to ensure freedom of rotation.

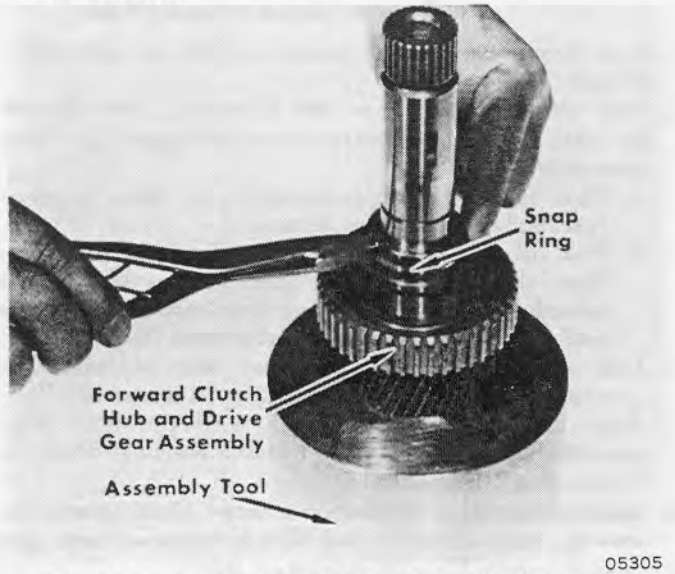


Figure 12. Installing Forward Clutch Sealing Rings on Drive Gear

22. With drive gear and clutch hub in assembly tool as shown in Figures 11 and 12, place ring gear and forward clutch assembly over drive gear. (Figure 15 in "Disassembly")
23. Lower ring gear and clutch assembly until internal teeth of clutch plates begin to engage teeth on forward clutch hub. Rotate ring gear to align teeth of plates with teeth on clutch hub. DO NOT force ring gear, or teeth will be damaged. When ring gear and clutch are in correct position, rear end of ring gear should be against assembly tool or "flush" with rear thrust face of drive gear. (Figure 13) DO NOT remove drive gear and clutch assembly from assembly tool or move drive gear forward until Steps 24, 25 and 26 are completed. Any movement of drive gear forward will disengage clutch plates from clutch hub and move sealing rings out of position.

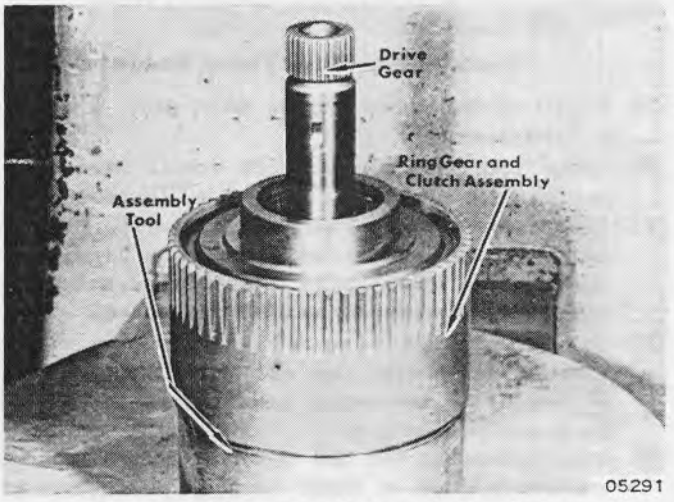


Figure 13. Assembling Ring Gear and Clutch Assembly on Drive Gear

24. Place aligned parts and assembly tool in place on arbor press. Place bearing over protruding drive gear and squarely into bore at front of forward clutch cylinder. Press bearing down with arbor press until bearing is fully seated on shoulder, and snap ring grooves in front of bearing are exposed. (Figure 14)

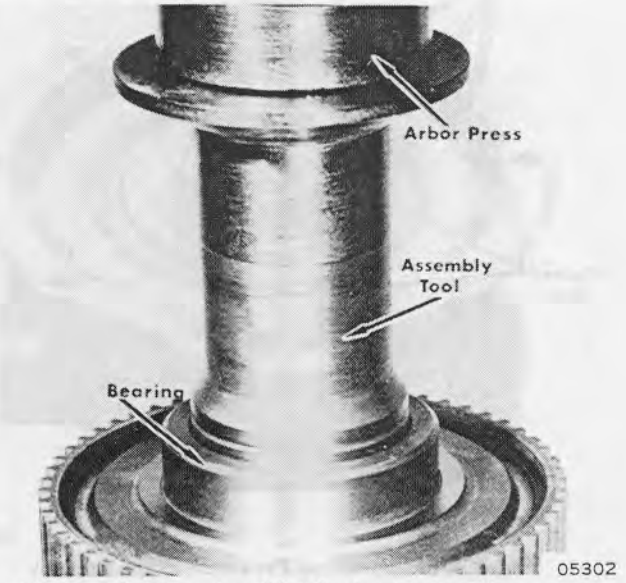


Figure 14. Pressing Clutch Bearing In Place

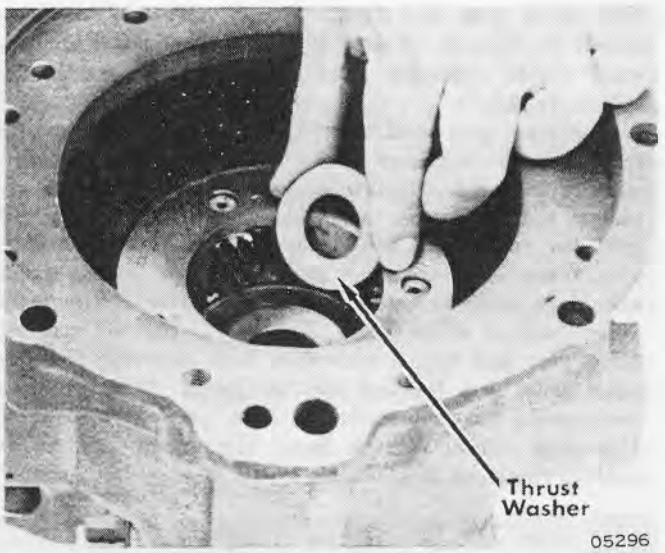


Figure 15. Installing Thrust Washer

25. Install external snap ring on drive gear. (Figure 14 in "Disassembly")
26. Using Snap Ring Pliers J-5586, install internal snap ring in clutch cylinder. (Figure 15 in "Disassembly")
27. Place transmission housing on a smooth, clean surface in upright position as indicated in Figure 15. In this position, rear face of rear coupling will provide sufficient base to enable assembly to proceed.
28. Coat drive gear thrust washer with petroleum jelly and assemble into pinion cage and output shaft assembly. (Figure 15) Center washer carefully over bore provided for on rear of drive gear.
29. After lubricating rear end of drive gear and checking centered position of thrust washer, install drive gear and clutch assembly into case and pinion cage and output shaft assembly. (Figure 13 in "Disassembly") Exert care and proper centering at this point to prevent damage to bushings when rear diameter of drive gear enters output shaft.

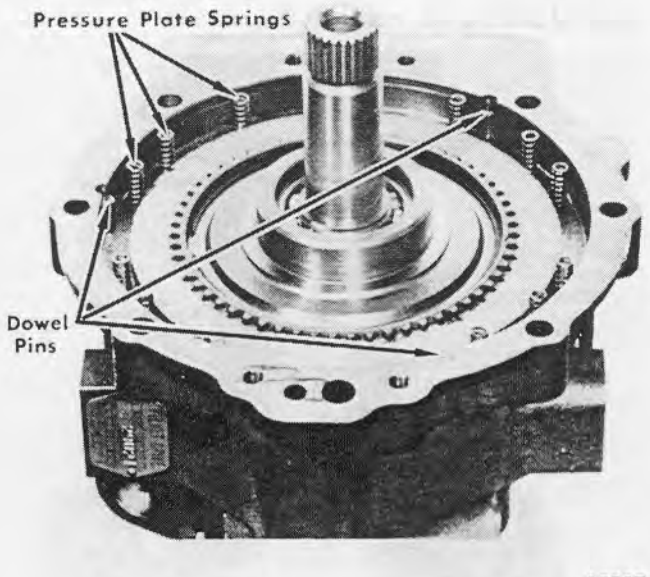


Figure 16. Installing Pressure Plate Springs and Dowel Pins

30. Install 12 pressure plate springs in holes provided in reverse clutch cavity. (Figure 16) Holes should be free from dirt, and all springs should be firmly seated.
31. Coat 3 dowel pins with petroleum jelly and assemble them in 3 grooves provided at outside diameter of reverse clutch cavity. (Figure 16) Assembly is complete when dowel pin is firmly seated on end and into groove, as far as groove contour will permit.
32. Install reverse clutch plates, (2 bronze and one steel for 71C Series and 3 bronze and 2 steel for 72C Series) over exposed splined teeth of ring gear. Clutch plate must be firmly and evenly seated on case face which forms rear of reverse clutch cavity.
33. Install reverse clutch pressure plate with 12 holes in down position. Align cast slot in pressure plate with large oil hole in front face of transmission case. (Figure 12 in "Disassembly") Since 12 pressure plate springs are not evenly spaced, slot and oil hole alignment are required to locate pressure plate with relation to pressure plate springs. (Figure 12 in "Disassembly") A properly assembled reverse pressure plate will appear as shown in Figure 17. If pressure plate does not drop down to position, approximately flush with transmission case front face, check 3 dowel pins for possible misalignment.

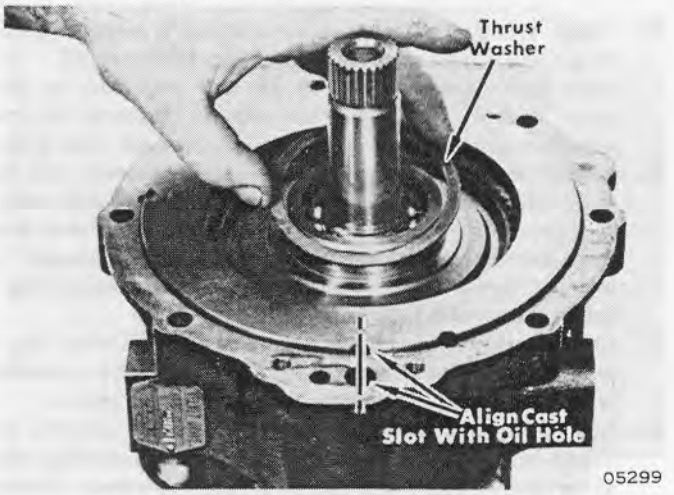


Figure 17. Installing Thrust Washer and Reverse Clutch Pressure Plate

34. Coat thrust washer with petroleum jelly and assemble. (Figure 17)
35. After checking adaptor for the following, place adaptor on clean surface in position shown in Figure 7 in "Disassembly":
    a. That needle bearing assembly is clean, properly installed and free from damage.
    b. That oil passages are free from dirt and obstruction.
    c. That the reverse clutch cavity outer wall has a smooth, clean surface, free from scratches or burrs and coated generously with petroleum jelly.
36. Coat sealing ring with petroleum jelly and install in groove of adaptor hub. (Figure 10 in "Disassembly")
37. After lubricating sealing ring with petroleum jelly, assemble in groove of reverse clutch piston as shown in Figure 9 in "Disassembly".
38. Examine inside diameter of reverse clutch piston for smooth, clean surface, free from scratches or burrs and coated generously with petroleum jelly.
39. Place reverse clutch piston on adaptor. (Figure 18) Press down on reverse clutch piston while pulling a

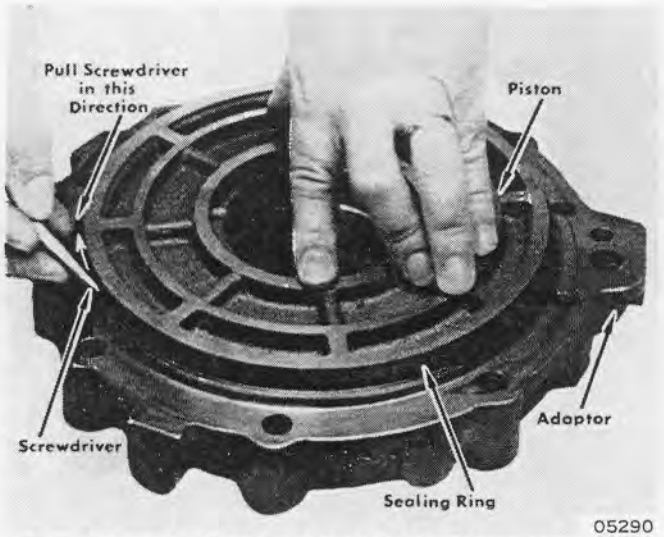


Figure 18. Installing Reverse Clutch Piston in Adaptor

smooth, clean screwdriver blade around exposed portion of sealing ring. This will aid chamfered bore in adaptor to compress sealing ring into groove in outside diameter of piston. Assembly can be completed by using hand pressure until piston has "bottomed" in reverse clutch cavity. Exposed face of clutch piston should be flush with adjacent surrounding surface on adaptor when assembly is completed.

40. Coat exposed front of transmission case with petroleum jelly and assemble case and adaptor gasket. (Figure 8 in "Disassembly")
41. Align oil holes as indicated in Figure 8 in "Disassembly", then lower reverse clutch piston and adaptor assembly squarely onto input gear and transmission case.
42. When shoulder on rear of adaptor has entered mating bore in reverse clutch cavity (located in front of transmission case) and check of gap between case and adaptor indicates that adaptor is squarely in place, install 4 cap screws. (Figure 7 in "Disassembly") Adaptor now can be pulled down squarely, until contact with case is made, by alternately tightening cap screws a small amount and checking frequently for binding. When adaptor is pulled down as far as possible, tighten 4 screws to 27 to 37 lbs. torque.
43. After installing new oil seal, lubricate pump housing with proper transmission oil and place as shown in Figure 19. Install lubricated driven pump gear with identification mark as shown in Figure 20.

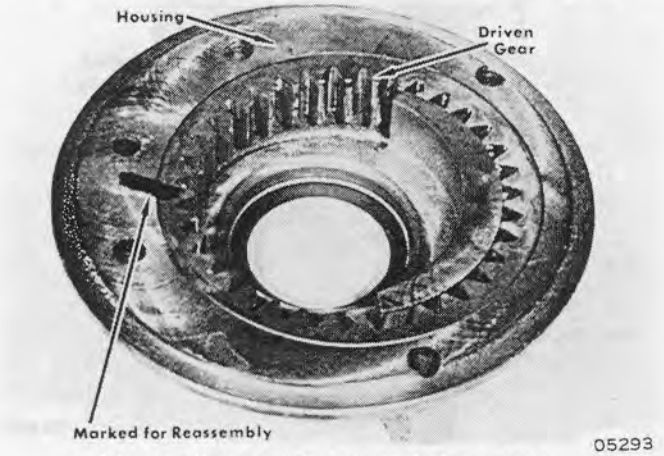


Figure 19. Installing Pump Driven Gear

44. Lubricate and install front pump gasket. (Figure 21)
45. Install woodruff key. (Figure 19)
46. Install pump drive gear on input shaft, with woodruff key slots in drive gear mating with woodruff key on the input shaft. (Figure 19)

NOTE: Assemble the 2 pump gears so that the same gear faces are matched with the machined face of the pump housing as found at disassembly. Marks should have been applied at disassembly to insure proper reassembly.

47. With pump driven gear properly installed in front pump housing, assemble housing and pump driven gear squarely over protruding input shaft. A slight rotation of pump driven gear will allow engagement of pump gear teeth. (Figure 21)

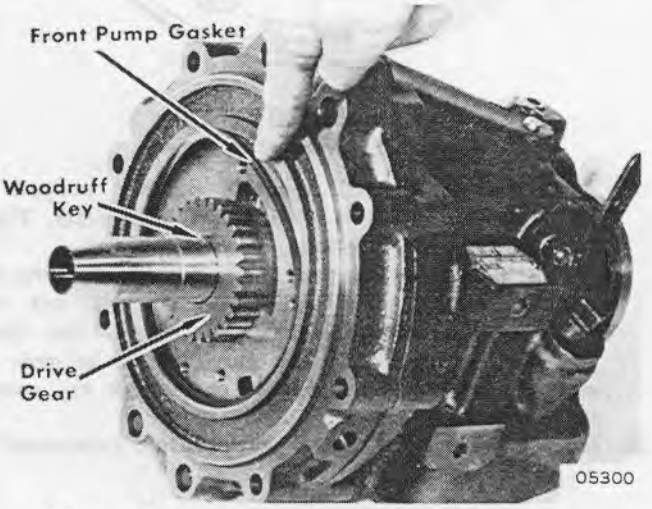


Figure 20. Installing Pump Drive Gear Key and Front Pump Gasket

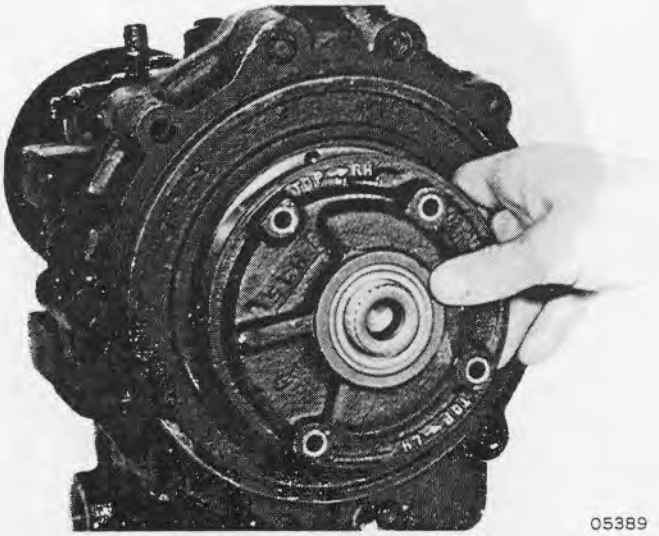
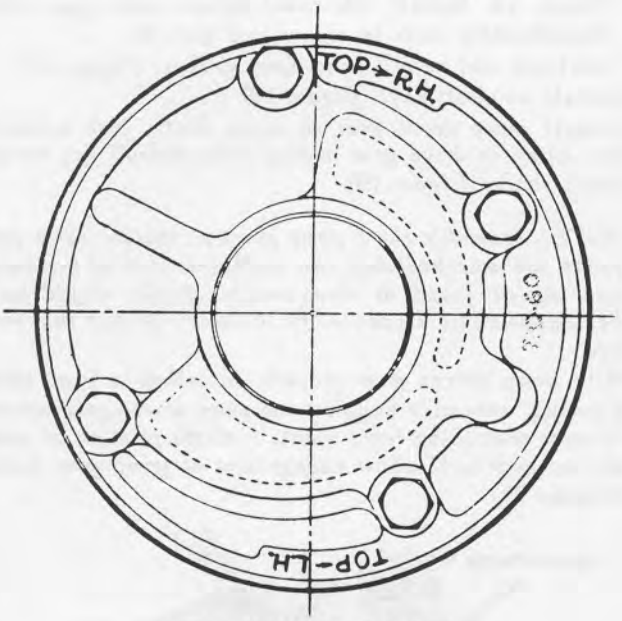


Figure 21. Installing Front Pump

NOTE: Wrap input shaft spline with tape to protect rubber lip on seal.

48. Orient pump mounting bolt holes and arrow (indicating direction of rotation) to correspond with direction of rotation required by engine, (Figure 22) If not installed for proper rotation, pump will not produce oil pressure to operate transmission when engine is started.



LEFT HAND ROTATION

Figure 22. Orientation Marks

49. With pump assembled squarely against adaptor and pump gasket, install 4 5/16-18 hex head bolts. Tighten hex head bolts evenly to torque of 17-22 lbs.
    Check freedom of rotation of pump gears in pump housing by rotating input shaft. If pump will not rotate freely, disassemble pump and check for foreign material in pump. Any dirt particles on adaptor face will cock pump when mounted on adaptor and cause it to seize.
50. Install "O" ring on end of control valve. Lubricate "O" ring with petroleum jelly.

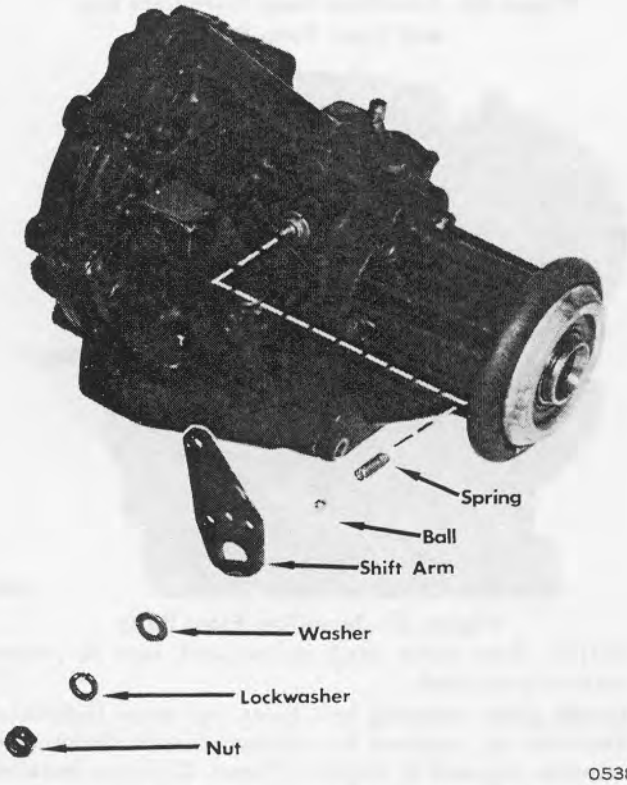


Figure 23. Assembly of Shift Lever

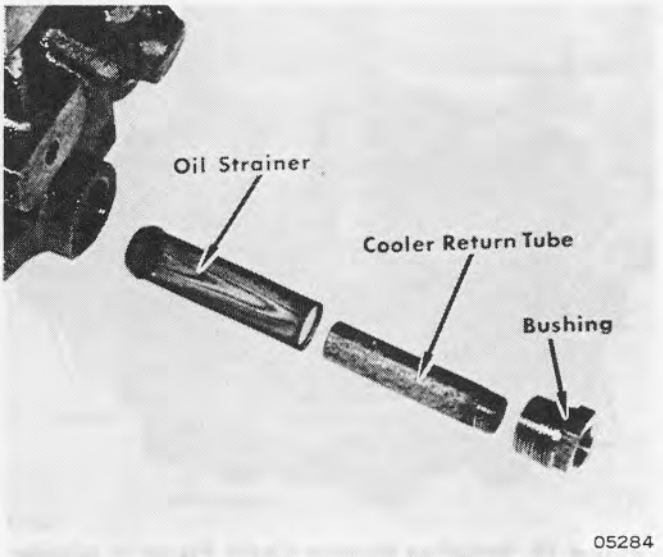


Figure 24. Installing Oil Strainer and Cooler Return Tube

51. Place valve and spring assembly (threaded end first in side of transmission case. (Figure 4 in "Disassembly")
52. To ensure neutral positioning of valve and easier assembly of lever, align .369-.376 width slot in valve with bottom 1/4-20 bolt hole in valve cover face of case. (Figure 4 in "Disassembly")
53. Assemble valve cover gasket, valve cover, lockwashers and hex head bolts. Torque hex head bolts to 8-11 ft. lbs.
54. Coat spring, ball and arm with Quicksilver Anti-Corrosion Oil (C-92-45134-12). Assemble shift lever and related parts in order shown in Figure 23. Torque hex nut 8-11 ft. lbs. Rotation of valve and spring assembly thru forward, neutral and reverse positions should require no more than fingertip effort. If valve binds in rotation, remove and inspect.

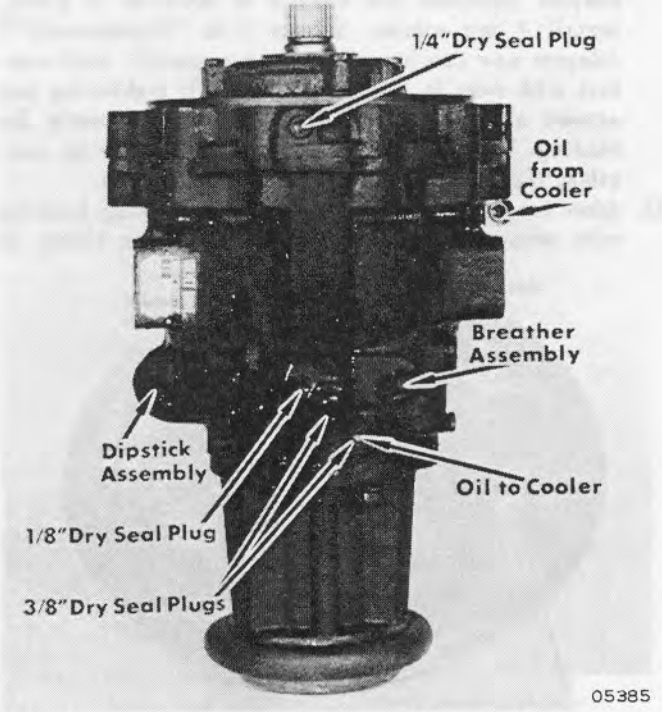


Figure 25. Installation of Pipe Plugs

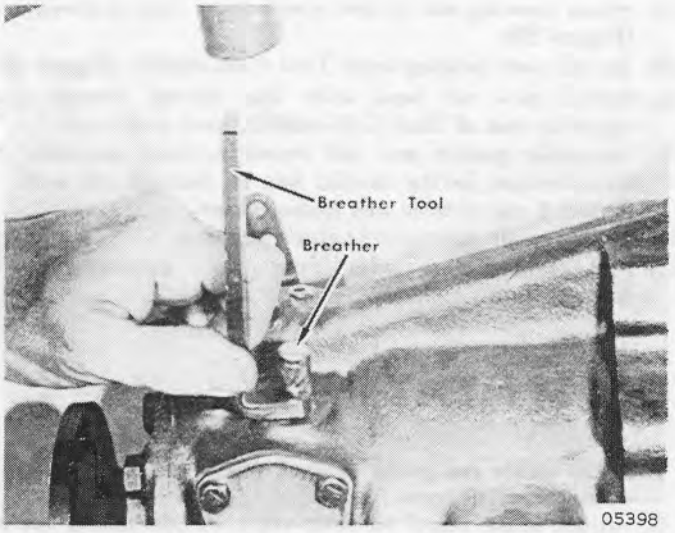


Figure 26. Installation of Breather Assembly

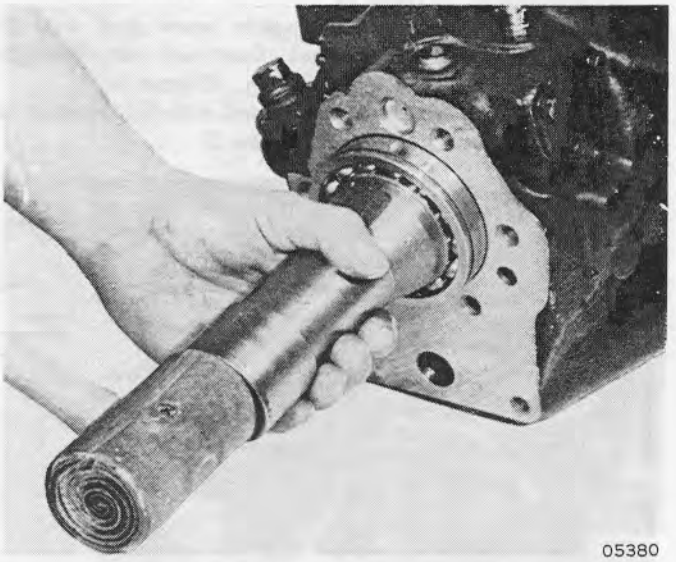


Figure 27. Installing Bearing and Shaft

Figure 28. Removing Tail Stock Oil Seal

Figure 29. Removing Tail Stock Bearing

55. Assemble oil strainer assembly, cooler line return bushing and cooler return tube assembly in order shown in Figure 24. Screen end of oil strainer assembly should be approximately ½" below face of case when assembly is correctly installed.
    Tighten cooler line return and oil drain bushing to recommended torque of 25-35 ft. lbs.
56. Install dipstick assembly and dry seal plugs (if removed). (Figure 25)
57. If breather assembly was removed, use assembly tool (Figure 26) and install new breather assembly. DO NOT hammer on top of breather assembly.
58. On engine coupling, check welch plug (located in center of coupling) for tightness. If loose, remove welch

Figure 30. Installing Tail Stock Bearing

plug, clean surfaces, coat surfaces with Loctite and drive in new welch plug. Check oil seal. Replace if damaged.

59. Inspect coupling bearing for wear or damage. To replace, remove snap ring and press bearing off coupling. Install bearing on engine coupling. Install snap ring.
60. Install bearing coupler assembly on output shaft spline. Tap coupling with mallet to seat bearing. (Figure 27)
61. If tail stock oil seal and bearing require replacement remove oil seal with appropriate tool. (Figure 28) Insert tool between bearing and seal and pry out seal.
62. Press bearing out of tail stock with Tool C-91-32325. (Figure 29)
63. Install new bearing with Tool C-91-48630. (Figure 30)
64. Install new oil seal with lips facing inward. Use opposite end of Tool C-91-48630. used previously.
65. Assemble gasket and tail stock housing assembly to transmission, being careful not to damage oil seal. Install 8 cap screws and lockwashers.
66. Install guide spring to engine coupling.
67. Fill transmission with Type "A" automatic transmission fluid.

SHIFT CABLE ADJUSTMENT

1. Place remote control handle in full forward position.
2. Place transmission in forward gear by moving shift cable lever to the right until detent ball (located behind transmission shift lever) is centered in rear hole in transmission shift lever. (Figure 1)

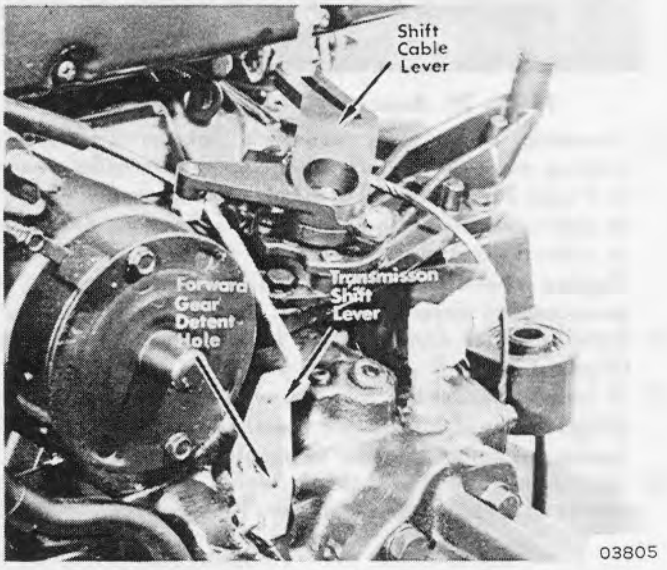


Figure 1. Transmission Shift Lever Position - Forward Gear

3. Remove roll pin, which passes thru knurled pin in cable end guide, and remove knurled pin and spring from end guide.
4. Place cable end guide on stud which is located in shift cable lever. (Figure 2)
5. Adjust brass barrel on shift cable so that barrel can be placed on anchor stud without disturbing shift cable lever position. (Figure 2)
6. Fasten end guide to shift cable lever stud with flat washer and nut. Tighten nut, then back nut off slightly to allow end guide to pivot freely. (Figure 2)
7. Fasten brass barrel to anchor stud with flat washer and nut. Tighten nut securely. (Figure 2)

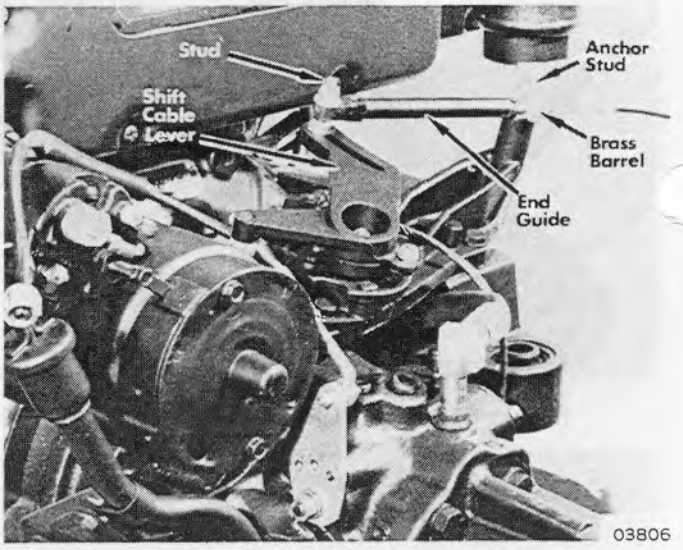


Figure 2. Shift Cable Installed

TOOLS

The assembly tool drawings (shown on this page) are included to illustrate how these tools may be made. Most will provide convenience in assembling and disassembling the transmission, but their functions may be performed by the substitution of other objects.

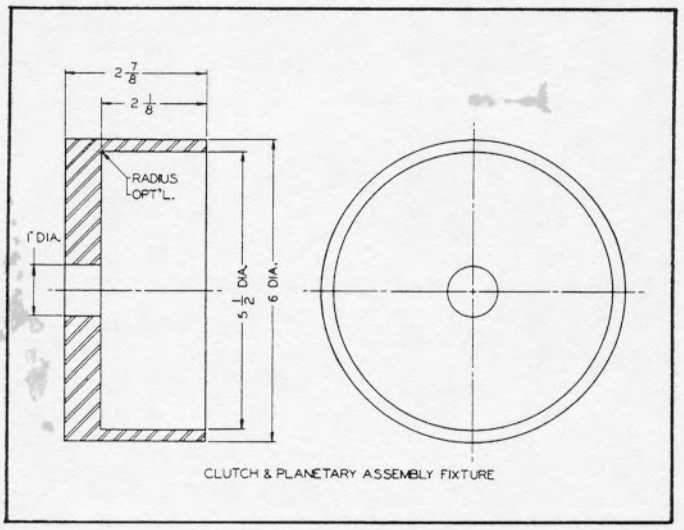


Figure 3. Drawing No. 1

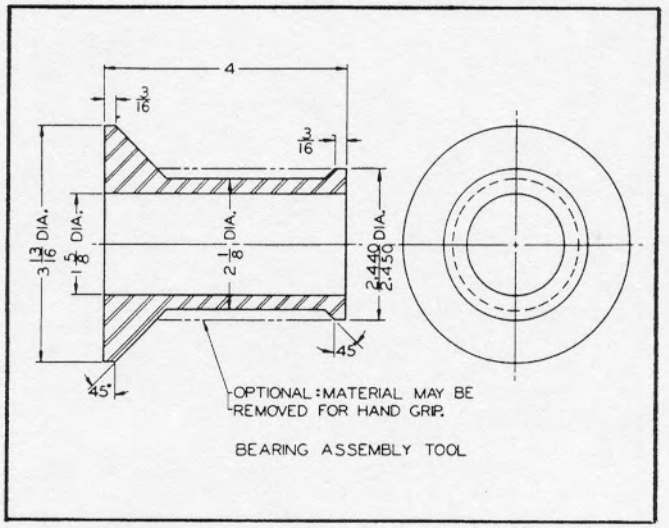


Figure 4. Drawing No. 2

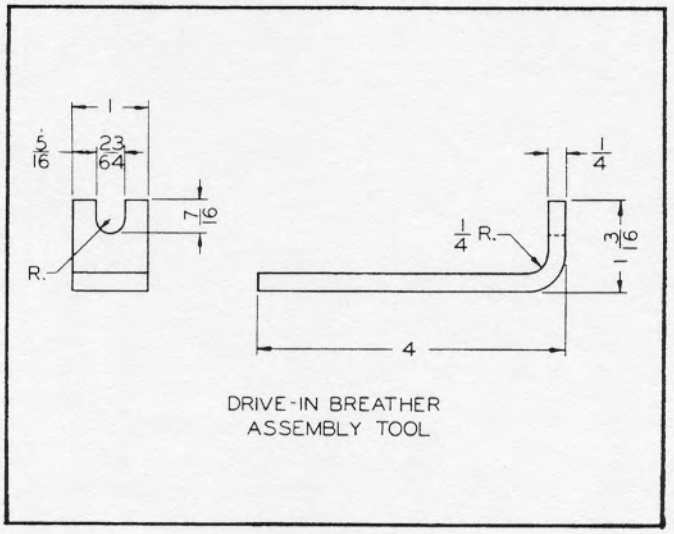


Figure 5. Drawing No. 3

All "J" (Special) Tools Listed Herein May Be Purchased from:

Kent-Moore, Inc.
28635 Mound Road
Warren, Michigan 48089

SECTION 6 - DRIVE SYSTEMS

MERCRUISER

PART E - DIRECT DRIVE TRANSMISSION

MERCURY MARINE

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STERN DRIVE DIRECT DRIVE TRANSMISSION SERIES 71 and 72

DESCRIPTION

The transmission consists of a planetary gear set, a forward clutch, a reverse clutch, an oil pump and a pressure regulator and rotary control valve. All are contained in a cast iron housing (along with necessary shafts and connectors) to provide forward, reverse and neutral operation.

A direct drive ratio is used for all forward operation. In reverse, speed of the output shaft is equal to input shaft speed, but in the opposite direction. Helical gearing is used to provide operation more quiet than can be obtained with spur gearing.

Shifting is accomplished by fore and aft movement of the shift lever. This movement rotates control valve and directs oil under controlled pressure to required channels.

Oil pressure is provided by the crescent type pump and drive gear which is keyed to the drive shaft. Pump operates at transmission input speed to provide screened oil to the pressure regulator.

From the regulator valve, oil is directed through proper circuits to bushings and anti-friction bearings which require lubrication. A flow of lubricant is present at the required parts whenever the front pump is turning, and it should be noted that supply is positive in forward, neutral and reverse conditions.

The unit has seals to prevent escape of oil.

Both input and output shafts are coaxial, with input shaft splined for installation of a drive damper, and output shaft splined for connecting to the stern drive unit.

PRECAUTIONS

1. Oil cooler must be properly connected to transmission before engine is cranked or started. Failure to properly connect oil cooler will cause forward clutch piston to blow out from over-pressurization.
2. Change oil and clean oil screen once each season.
3. Check oil level at operating temperature.
4. Use clean containers for handling transmission fluid.
5. Fill transmission prior to starting engine.
6. Check oil level immediately after engine is shut off.
7. Use recommended automatic transmission fluids Type "A" Suffix "A" or new Dexron fluid.
8. Flush cooler and cooler lines after a transmission failure and prior to installing a new or rebuilt transmission.
9. Check engine alignment each time a transmission is replaced in boat.
10. Check shift linkage adjustment to insure that transmission shift lever is being positioned so that spring-loaded ball enters chamfered hole inside of shift lever in each selected position.
11. Check oil pressure and temperature when transmission functions indicate that a problem exists.
12. Always check pump hand of rotation prior to assembling transmission to engine to ensure that pump is properly indexed for engine rotation.
13. Except in emergency, never shift at engine speeds above 1000 RPM.
14. Never remove oil cooler lines or use smaller than recommended 13/32" diameter cooler lines when operating transmission.
15. Do not permit propeller shaft to rotate when transmission is inoperative. Propeller shaft rotation could be caused by towing, sailing or operation of second engine which could move the boat through the water and cause propeller to "windmill."
16. Ribbon dope (a thread sealant) must be used on hydraulic connections. when hydraulic lines are installed, to prevent hydraulic fluid from leaking.

LUBRICATION RECOMMENDATIONS

The properties of the oil used in the transmission are extremely important to the proper function of the hydraulic system. Therefore, it is necessary that the recommended oil, automatic transmission fluid (ATF), Type "A", Suffix "A", be used.

PROCEDURE for FILLING TRANSMISSION with OIL

When filling transmission, add oil until it reaches full mark on dipstick. Quantity of oil depends upon angle of installation, but information to serve as a guide on possible amount needed may be found in chart following. Unit should be turned over at engine idle speed for a short time in order to fill all circuits, including cooler and cooler piping.

NOTE: Be sure that cooler is properly installed and that transmission contains oil before cranking or starting engine.

PROCEDURE for CHECKING OIL LEVEL

Oil level should be checked immediately after stopping engine, and sufficient oil added to again bring transmission oil level to full mark on dipstick assembly. Dipstick assembly need not be threaded into case to determine oil level. Merely insert into case until cap or plug rests on surface surrounding oil filler hole.

Transmission should be checked periodically to assure proper oil level, and oil should be added if necessary.

CHANGING OIL

It is recommended that transmission oil be changed once each season. After draining oil from unit, thoroughly clean the removable oil screen before refilling transmission with recommended oil (ATF), Type "A", Suffix "A".

NOTE: Oil capacity does not include capacity needed for transmission cooler and oil lines, which may require an amount greater than in table on right.

OIL CAPACITY

Transmission Model	Transmission Oil Capacity (Quarts)	
	Level	15° Inclined
AS 1-71C	1.8	1.3
AS 1-72C	2.1	1.7

KEY to TROUBLESHOOTING CHART on PAGE 6E-3

1. *Loose bolts - tighten.*
2. *Damaged gasket.*
3. *Damaged oil seal.*
4. *Oil line fittings loose - tighten.*
5. *Case leaks, porosity - replace.*
6. *Oil filler plug or cap leaks - replace or tighten.*
7. *Damaged control valve "O" ring.*
8. *Foreign material on mating surfaces - clean.*
9. *Damaged oil cooler, water and oil mixing - replace.*
10. *No oil - check at once.*
11. *Pump improperly located for engine rotation - locate correctly.*
12. *Sheared drive key - replace.*
13. *Faulty oil gauge - clean or replace, bleed air from gauge line.*
14. *Dirty oil screen - clean or replace.*
15. *Low oil level - add oil to proper level.*
16. *Regulator valve stuck - replace valve.*
17. *Worn oil pump - replace if necessary.*
18. *Regulator spring weight low - replace valve.*
19. *High oil level - drain oil to proper level.*
20. *Low water level in cooling system.*
21. *Dirty oil cooler - clean.*
22. *Worn or misaligned bushings in transmission case - replace.*
23. *Worn or damaged clutch piston oil seals.*
24. *Worn or damaged clutch sealing rings.*
25. *Clutch improperly assembled.*
26. *Damaged or broken belleville spring.*
27. *Worn or damaged clutch plate(s) - replace.*
28. *Damaged or broken clutch springs.*
29. *Regulator valve not notched - replace valve.*
30. *Inadequate torque on output shaft nut - tighten.*
31. *Nicks on gears - remove with stone.*
32. *Excessive runout between engine housing and crankshaft.*
33. *Damaged damper assembly parts - replace.*
34. *Body - fit bolts not used in mounting holes.*
35. *Control linkage improperly adjusted.*
36. *Control lever and poppet ball corroded - clean and lubricate.*
37. *Control linkage interference - check.*
38. *Wrong oil used in transmission - change.*
39. *Cold oil.*
40. *Planetary gear failure - replace or repair if necessary.*

TROUBLESHOOTING CHART

COMPLAINTS and SYMPTOMS	REMEDY	
	TRANSMISSION in BOAT	TRANSMISSION REMOVED
Internal and External Leaks		
Oil leaks at pump		1 2 3 8
Oil on exterior of transmission	1 4 6 7	2 5 8
Oil leaks at rear bearing retainer	1 2* 3* 8	
Water in transmission oil or oil in cooling water	9	
Transmission Malfunctions in All Ranges		
No oil pressure	10	11 12
Low oil pressure	13 14 15 16 18	17
High oil temperature	9 15 19 20 21	40
Failure of reduction gear		40
Transmission Malfunctions in Forward Range		
Low oil pressure	13 14 15 16 18	17
Forward clutch engages improperly	35	12 22 23 24 25 26 27
Forward clutch drags	35	25 26 27
Reduction unit failure		40
Transmission Malfunctions in Reverse Range		
Low oil pressure	13 14 15 16 18	17
Reverse clutch engages improperly	35	23 25 27 28
Reverse clutch drags	35	25 27 28
Reverse gear set failure		40
Reduction gear set failure		40
Transmission Malfunctions in Neutral		
Output shaft drags excessively in forward rotation	35	25 26 27
Output shaft drags excessively in reverse rotation	35	25 27 28 40
Miscellaneous Transmission Problems		
Regulator valve buzz	29	
Gear noise-forward	30	31
Gear noise reverse	30	31 40
Pump noise	15	17 31
Damper noise or failure		32 33 34
Shifts hard	16 37	7 35 36
High oil pressures	16 38 39	

**If installation allows access, otherwise remove transmission.*

71 and 72 SERIES TRANSMISSION (STERN DRIVE)

1 - Transmission Assembly
2 - Bushing Kit
3 - Breather
4 - Spring, poppet
5 - Ball, detent
6 - Dipstick
7 - Spring and Valve Assembly
8 - "O" Ring
9 - Cover, valve
10 - Gasket
11 - Screw
12 - Lockwasher
13 - Strainer, oil
14 - Tube, oil strainer
15 - Bushing
16 - Baffle, oil
17 - Gasket
18 - Ring, snap
19 - Washer, thrust
20 - Pinion Gear and Shaft Assembly
21 - Washer, thrust
22 - Key
23 - Drive Gear and Shaft Assembly
24 - Gear, forward clutch
25 - Ring, snap
26 - Key
27 - Ring, sealing
28 - Gear, ring
29 - Plate, pressure
30 - Plate, clutch (outer) bronze
31 - Plate, clutch (inner) steel
32 - Plate, pressure
33 - Spring, clutch plates
34 - Ring, sealing
35 - Ring, forward clutch piston
36 - Piston, forward clutch
37 - "O" Ring
38 - Cylinder, forward clutch
39 - Ball Bearing
40 - Ring, snap - ball bearing ret.
41 - Ring, snap - ball bearing ret.
42 - Washer, thrust
43 - Ring, snap
44 - Plate, reverse clutch
45 - Plate, reverse clutch
46 - Pin, dowel
47 - Spring
48 - Plate, pressure
49 - Ring, sealing
50 - Piston, reverse clutch
51 - "O" Ring
52 - Adaptor
53 - Roller Bearing
54 - Screw
55 - Gasket
56 - Front Pump Assembly
57 - Oil Seal
58 - Screw

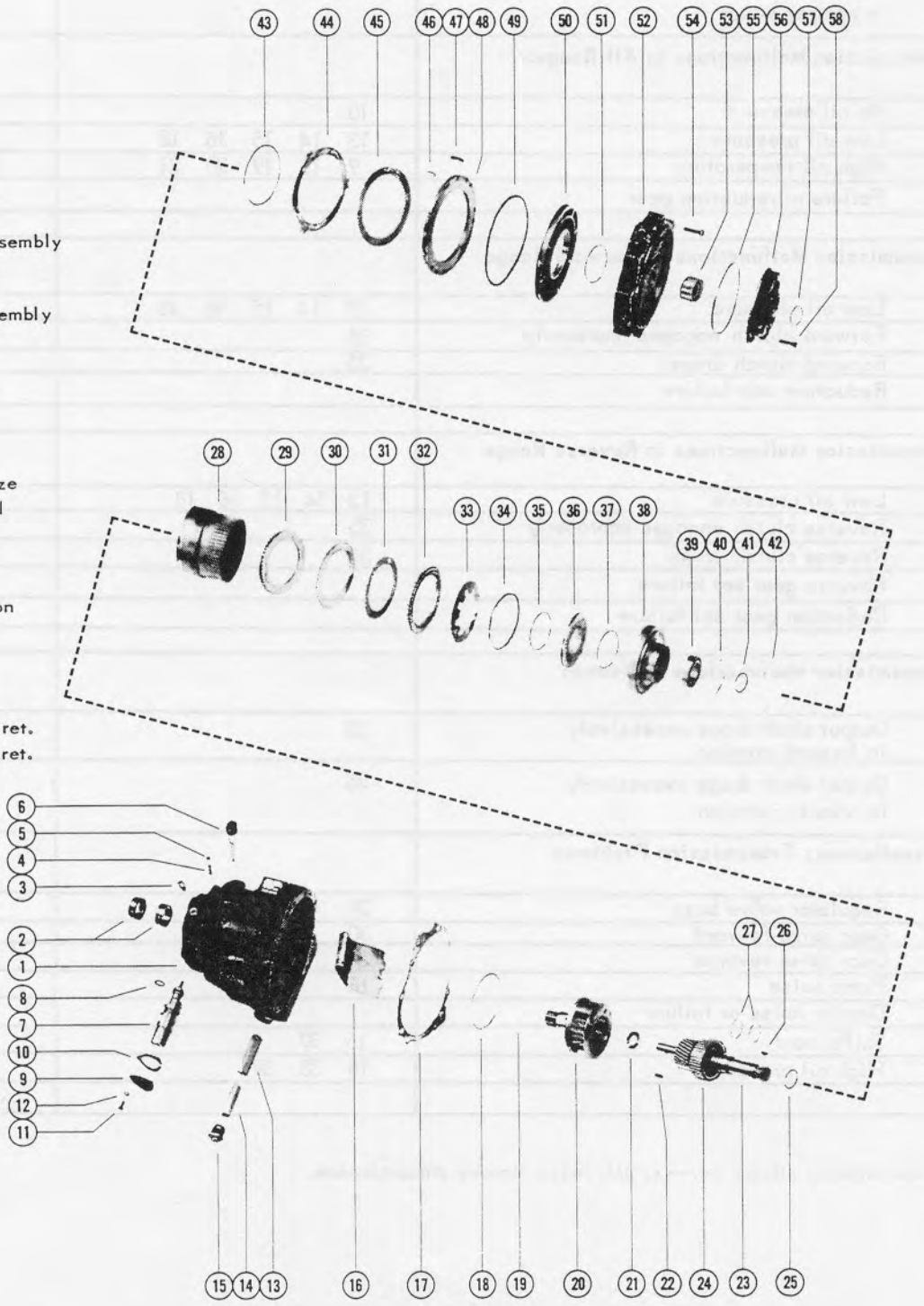


Figure 1. Transmission, Exploded View

REMOVAL

NOTE: Engine must be removed to remove transmission. Refer to "Removal - Installation - Alignment", Section 2.

1. Remove shift linkage and oil lines.
2. Remove rear engine mounts from transmission.
3. Remove 6 bolts which attach transmission to flywheel housing.
4. Remove transmission.

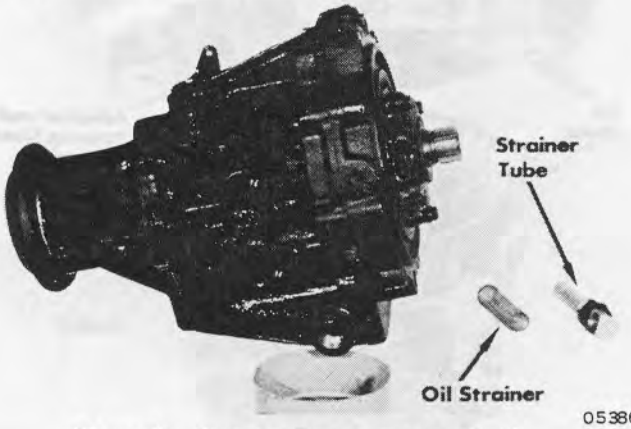
DISASSEMBLY

NOTE: Some tools are not available and must be fabricated. Refer to "Tools" at the end of this PART. Tear down procedure should not begin until transmission exterior and work area have been thoroughly cleaned.

1. Remove oil filler plug, located below shift lever on rear side of transmission case.
2. If space permits, place container with approximately 2 quart capacity under transmission, located as shown in Figure 2. Unscrew drain plug and cooler return tube assembly. Reach into opening with a suitable tool and remove strainer assembly. (Figure 2) Allow oil to drain into pan.
3. Remove engine coupling guide spring.
4. Remove 8 cap screws and lockwashers and remove tail stock housing and gasket.

NOTE: Tap housing with mallet to break loose. See Step 61 for tail stock service.

5. Tap engine coupling assembly with mallet to remove.



05386

Figure 2. Draining Transmission Fluid

NOTE: Bearing may be assembled upside-down, with groove not useable or no groove at all.

6. Tap shaft to remove shaft and bearing. (Figure 3)
7. Using Snap Ring Pliers (J5586), remove ring retainer, which holds bearing on shaft, and press shaft thru bearing.
8. Remove nut, lockwasher and flat washer from shift lever and remove shift lever.

> **CAUTION: Remove shift lever carefully; DO NOT lose indent ball and spring.**

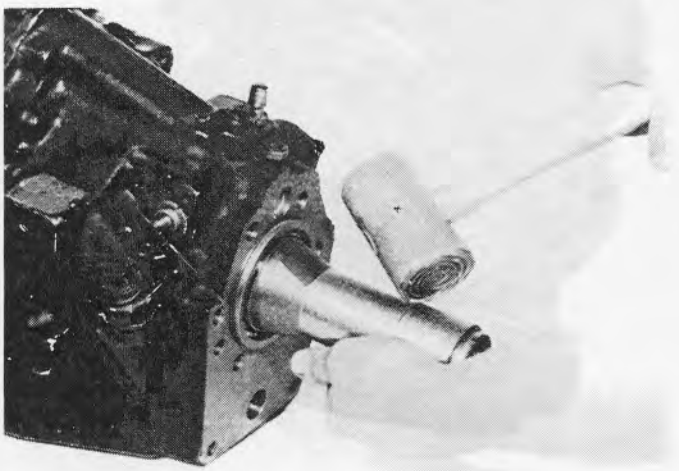


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Figure 3. Removing Bearing and Shaft from Case

9. Remove 3 screws and lockwashers, valve cover and gasket. Tap out valve assembly. (Figure 4)
10. Remove 4 cap screws from oil pump. Apply tape around input shaft splines.

NOTE: Note location of arrow on pump. Being careful not to damage seal lip, lift pump assembly squarely over protruding input shaft.

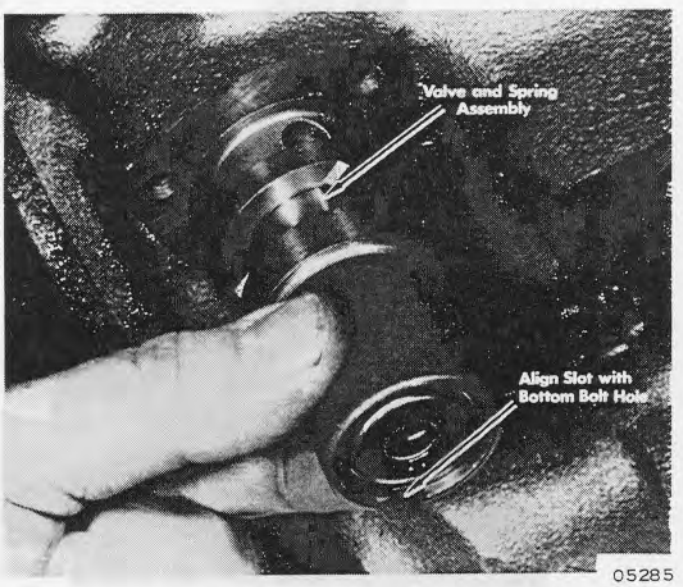

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Figure 4. Valve Removal

11. Remove pump drive gear, front pump gasket and woodruff key. (Figure 5)
12. Mark gears to identify proper relocation of gear faces during reassembly.

NOTE: Pump and drive gear are a matched set and are not sold separately.

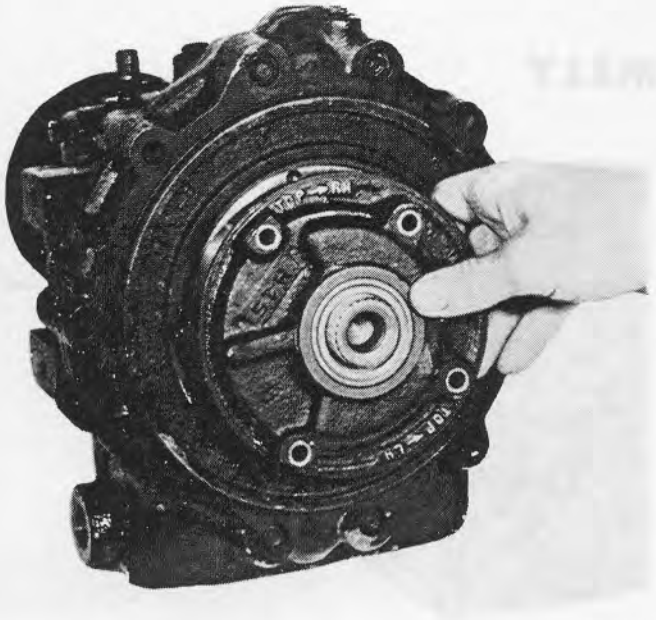

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Figure 5. Removing Oil Pump

13. To replace oil seal in pump housing, place pump housing squarely on arbor press table. Apply Loctite to outside diameter of seal and press seal into housing with Tool J-22922 until front face of seal is flush with front face of pump housing. (Figure 6)

NOTE: Wipe away any excess Loctite.

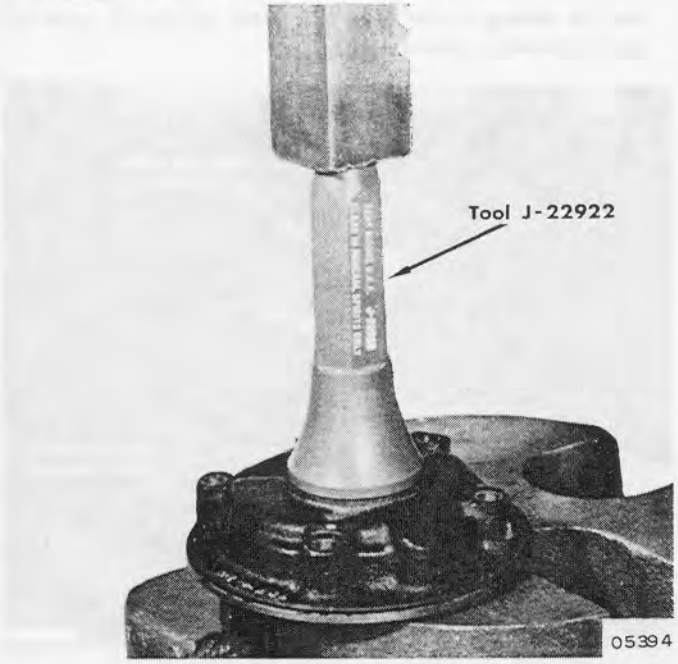

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Figure 6. Oil Seal Installation

14. Remove 4 cap screws (12 point head). (Figure 7) Lift adaptor and reverse clutch piston. (Figure 8) If necessary, tap adaptor with a soft hammer to remove.

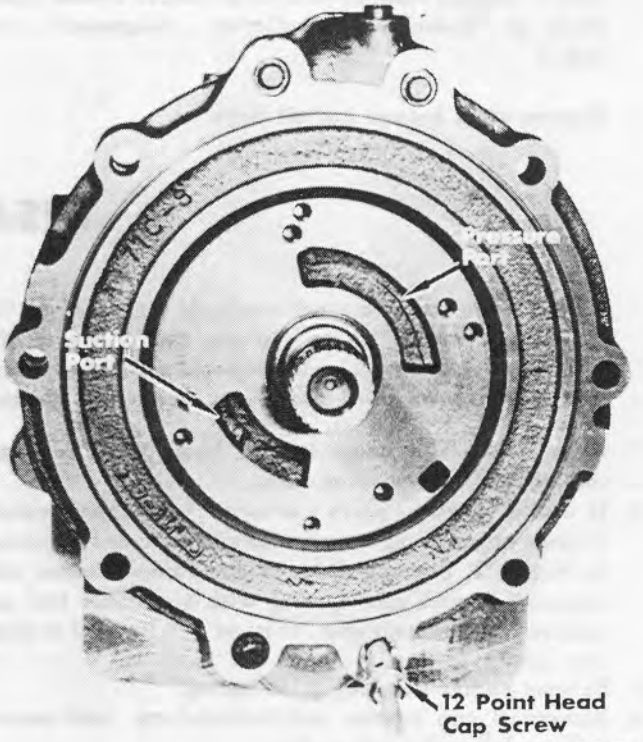

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Figure 7. Removing Adaptor

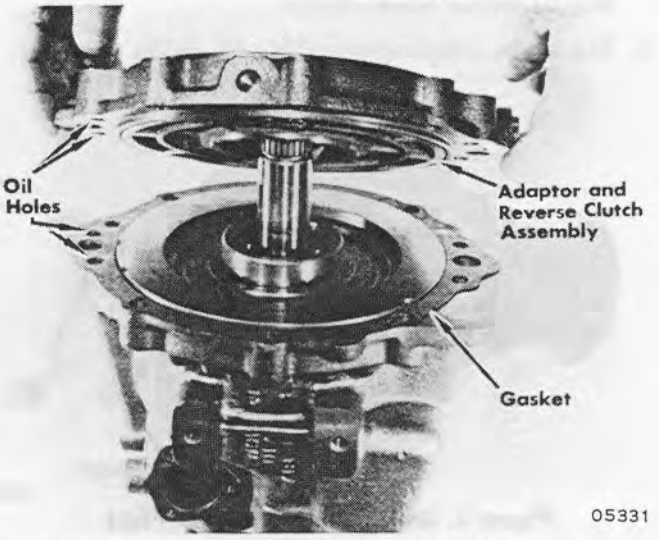

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Figure 8. Removing Adaptor and Reverse Clutch Assembly

> CAUTION: Reverse clutch pressure plate may stick momentarily to reverse clutch piston. To avoid damage, prevent pressure plate from dropping.

15. Force compressed air into reverse clutch cavity while holding piston, as shown in Figure 9, and piston will pop out of reverse clutch cavity.
16. Remove sealing rings as shown in Figures 10 and 11.

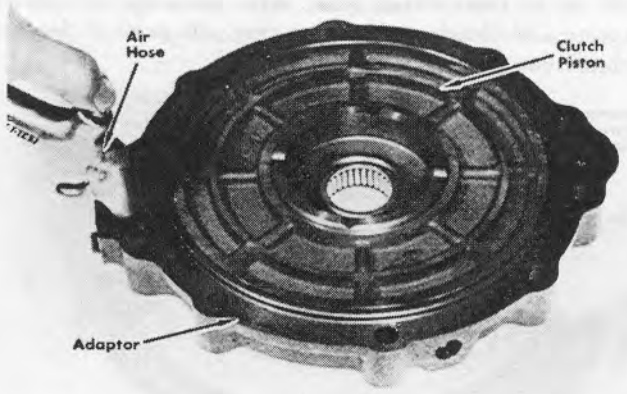

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Figure 9. Disassembling Reverse Clutch Piston

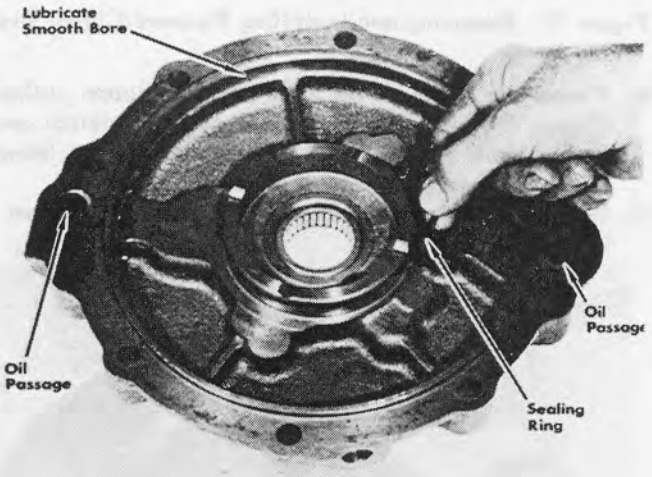

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Figure 10. Removing Sealing Ring

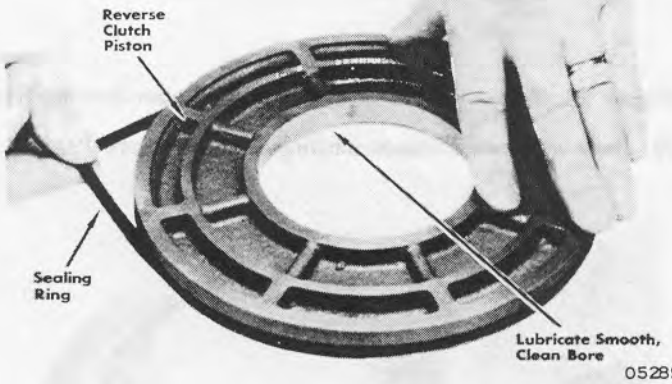

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Figure 11. Removing Outer Sealing Ring

17. Check needle bearing in adaptor for wear. Replace if worn, using tools.
18. Remove thrust washer (Item 42), clutch pressure plate (48), 12 pressure plate springs (47) and 3 dowel pins (46) (Figure 12) and reverse clutch pressure plates.
19. Grasp exposed front end of input gear and lift straight up. Drive gear and clutch assembly parts easily. Lift out of opening in front. (Figure 13)

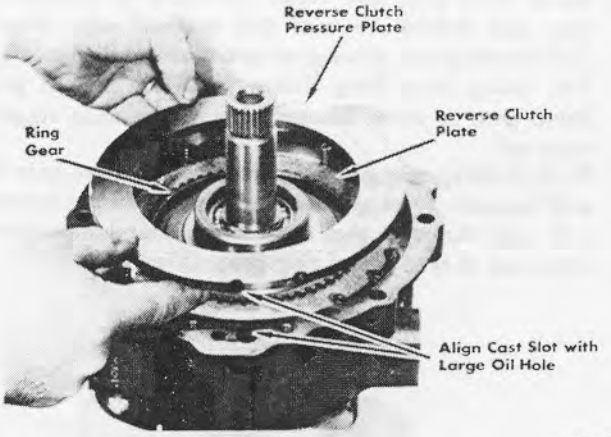

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Figure 12. Removing Reverse Clutch Pressure Plate

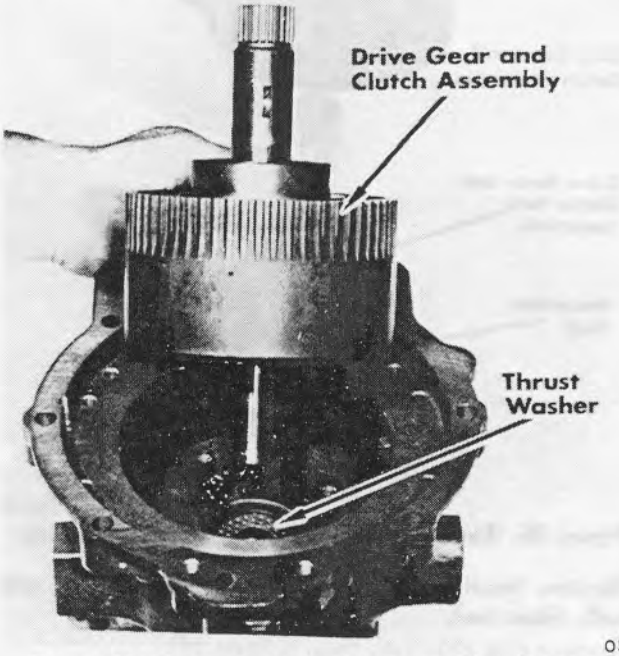

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Figure 13. Removing Drive Gear and Clutch Assembly

20. Remove thrust washer, located between drive gear and planetary carrier.

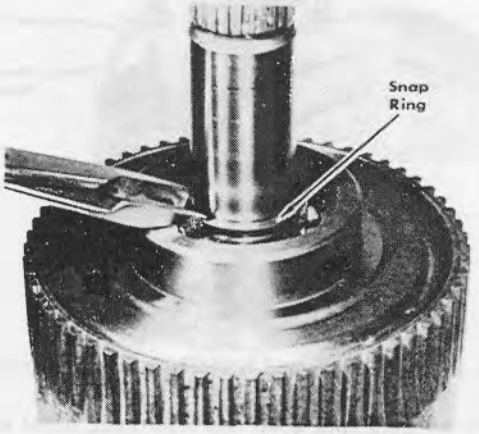

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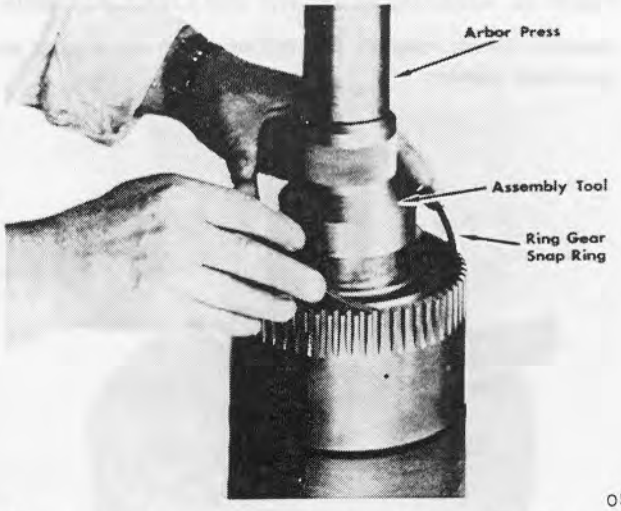
Figure 14. Removing Snap Ring

21. Stand drive gear and clutch assembly in suitable fixture and remove internal and external snap rings at ball bearing from drive gear and clutch cylinder (Figure 14), using Snap Ring Pliers (J-5586). Do not permit drive gear to move forward after above snap rings are removed.
22. While holding ring gear, tap front end of drive gear with soft hammer. Drive gear and forward clutch hub assembly will pass thru ring gear and forward clutch assembly to come out of rear end of ring gear. (Figure 15)

05315

Figure 15. Removing Ring Gear and Clutch Assembly

23. Remove bearing from clutch cylinder by tapping with soft, blunt tool.
24. Remove ring gear snap ring. (Figure 16)



05308

Figure 16. Removing and Installing Ring Gear Snap Ring

25. While holding ring gear, tap with soft, blunt tool on exposed face of forward clutch cylinder inside of ring gear. Forward clutch cylinder will move forward to disassemble out of front of ring gear. After removing the clutch spring and clutch spring snap ring, all parts of forward clutch can be disassembled.

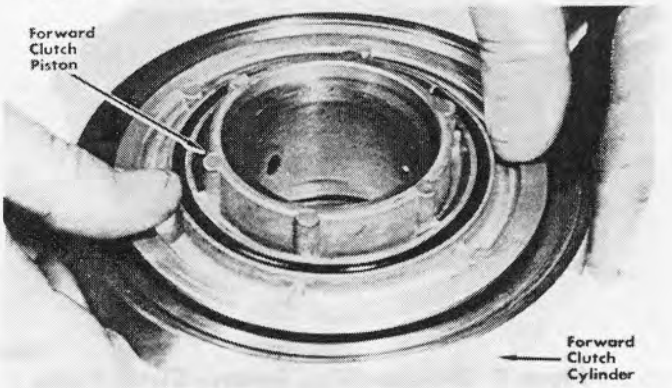


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Figure 17. Removing and Installing Forward Clutch Piston

26. Piston can be removed from forward clutch cylinder (Figure 17) by applying compressed air to clutch cavity through one of 3 holes in inside diameter of forward clutch cylinder, while other holes are blocked.
27. Remove forward clutch sealing rings, as shown in Figures 18 and 19.

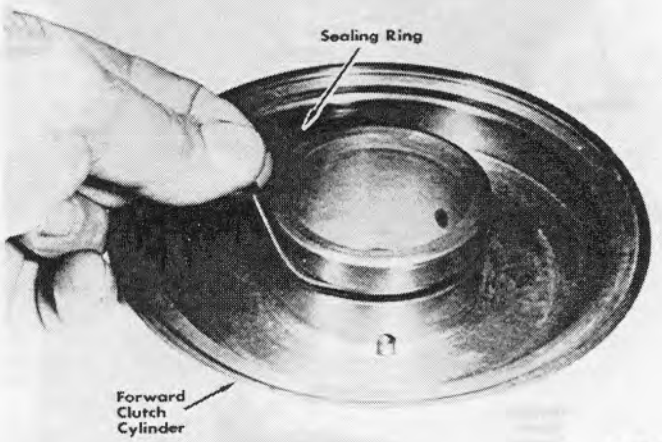

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Figure 18. Removing Forward Clutch Cylinder Sealing Ring

28. Remove forward clutch sealing rings. (Figure 19)

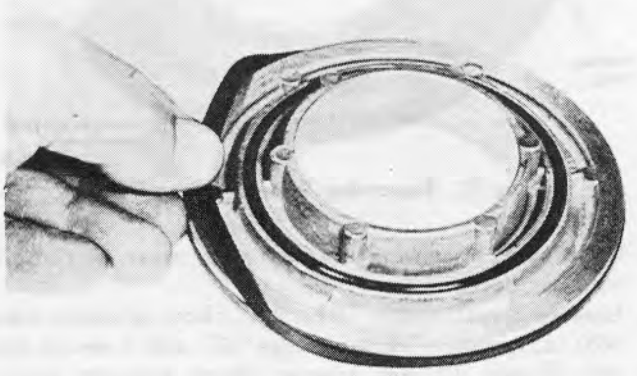

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Figure 19. Removing Forward Clutch Piston Sealing Ring

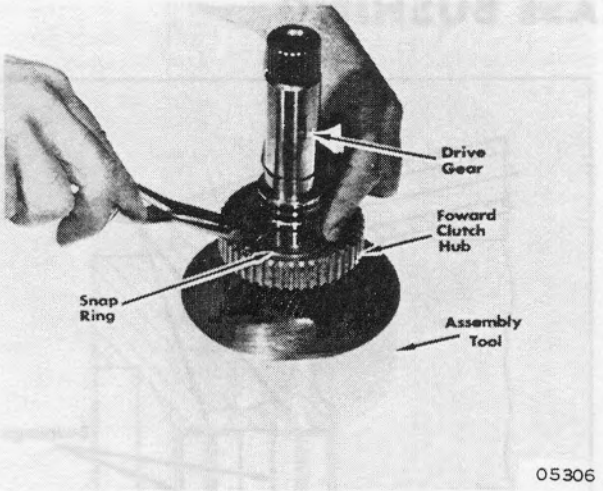


Figure 20. Removing Clutch Hub Snap Ring

29. Using Snap Ring Pliers (J-5586), remove snap ring from forward clutch hub and drive gear. (Figure 20)
30. If drive gear must be replaced, press clutch hub shaft out of drive gear. (Figure 21)
31. Remove pinion cage and output shaft by lifting out of transmission housing.
32. Remove thrust washer from pinion cage and output shaft.
33. Remove oil baffle from transmission housing by pressing down on baffle and pulling baffle out.

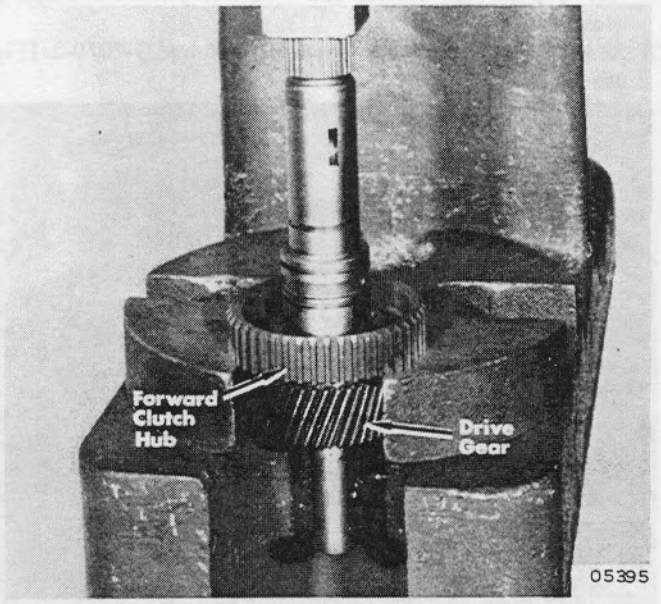


Figure 21. Pressing Clutch Hub Shaft from Drive Gear

TRANSMISSION CASE BUSHING

1. Check bushings for fit and wear. Replace bushings as required.
2. Remove bushings with Tools J-8466 and J-7079-2. (Figure 1)

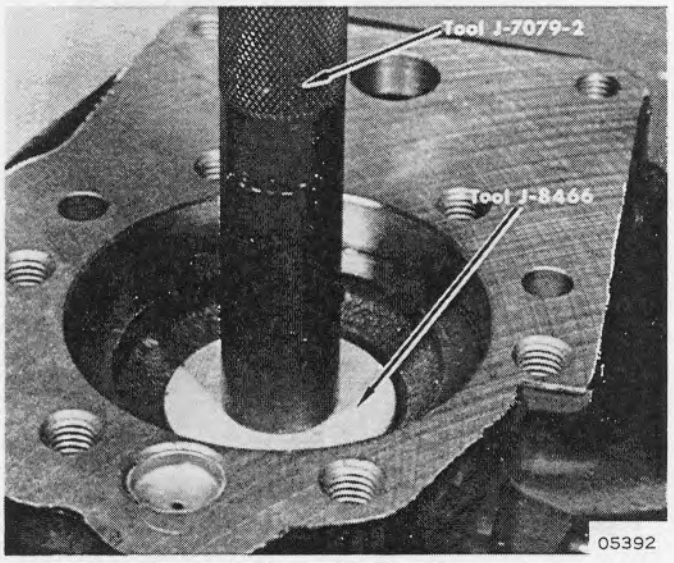


Figure 1. Case Bushing Removal

3. Check bore size. Bore should be 1.989" to 1.990". If bore exceeds this dimension, replace housing. (Fig. 2)
4. Coat inside of bore with Loctite Retaining Compound 35 (C-92-58254A1).
5. Install new bushing from Bushing Kit B-23-56572 with Tools J-8466 and J-7079-2. Bushings are pressed in from their respective ends.

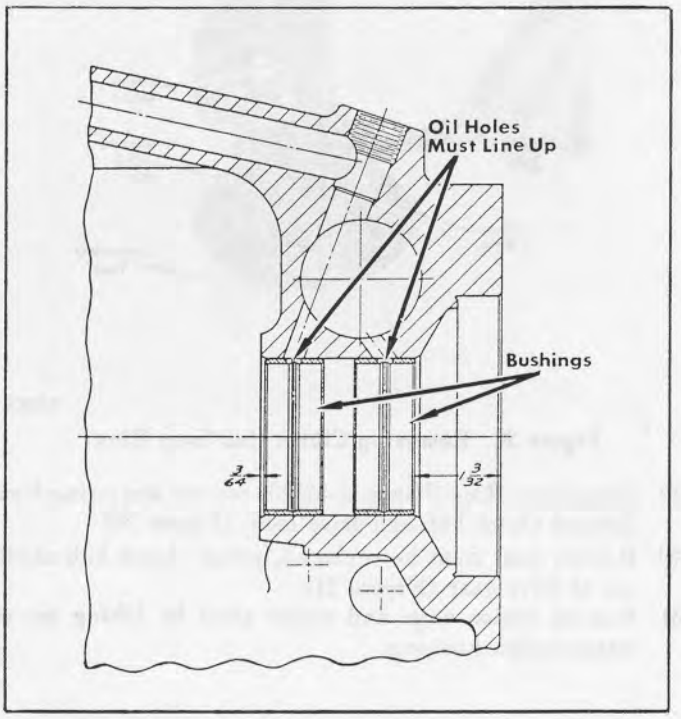


Figure 2. Case Bushing Installation

NOTE: Oil holes in bushings must line up with oil holes in case. Assemble each bushing in case bore from its respective end.

OUTPUT SHAFT BUSHING

1. Check bushings for fit and wear. Replace bushings as required.
2. Press bushings from output shaft with Tool C-91-58868. (Figure 3)
3. Coat inside of bore with Loctite Retaining Compound 35 (C-92-58254A1) and install new bushings from 2 Bushing Kits (B-23-56562) with Tool C-91-58868. Discard extra bushing.

NOTE: Oil holes in bushings must line up with oil holes in shaft.

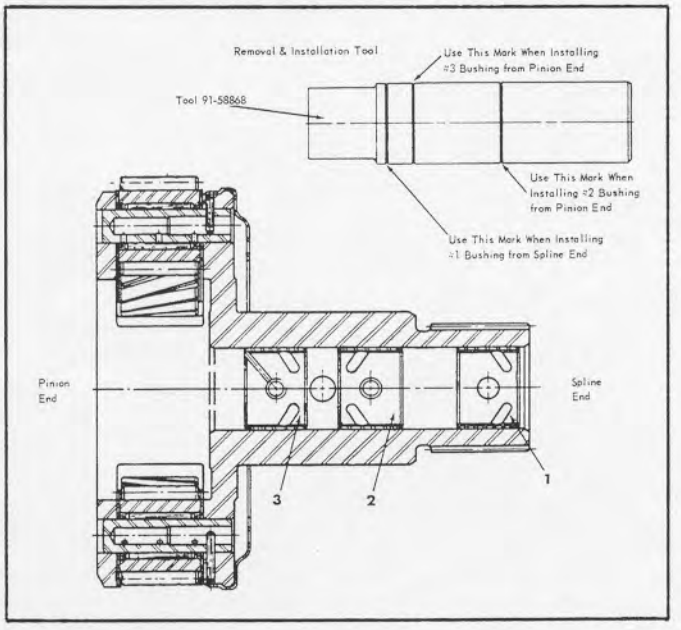


Figure 3. Shaft Bushing Installation

CLEANING and INSPECTION

1. Cleanliness is absolutely necessary during reassembly to ensure proper functioning of transmission. Transmission case passages always should have pipe plugs removed to allow for thorough cleaning. When available, use compressed air to dry parts before they are assembled. Do not wipe parts with rags to clean or dry them, as lint from the cloth may cause erratic valve action.
2. Inspect all parts for damage or wear. Replace defective parts.
3. All gaskets, oil seals and rubber sealing rings should be replaced, except in relatively new units. Judgement should be exercised as to need for replacing parts.
4. Oil seals and bearings are best installed by using an arbor press, suitable fixtures and tools to properly align parts being assembled. Hammering seals and bearings into position can severely damage parts.
5. Use automatic transmission fluid Type "A" Suffix "A" to lubricate parts as they are assembled. Petroleum jelly may be used on gaskets or other parts that must be held in position during assembly. All rubber parts will slide more freely if lubricated.
6. Tighten all bolts and screws evenly to recommended torque shown in Section 8.

REASSEMBLY

1. Place oil baffle inside transmission case with curved portion below cast spherical bosses in case, as shown in Figure 4.
2. Position front end of baffle so that center of baffle rests on top of boss at front center of transmission case, and the turned down corners of baffle are located below cast spherical bosses at front of transmission case. Snap baffle into position by lifting up on curved portion so that the 2 large holes are located firmly on spherical bosses at rear of transmission case.

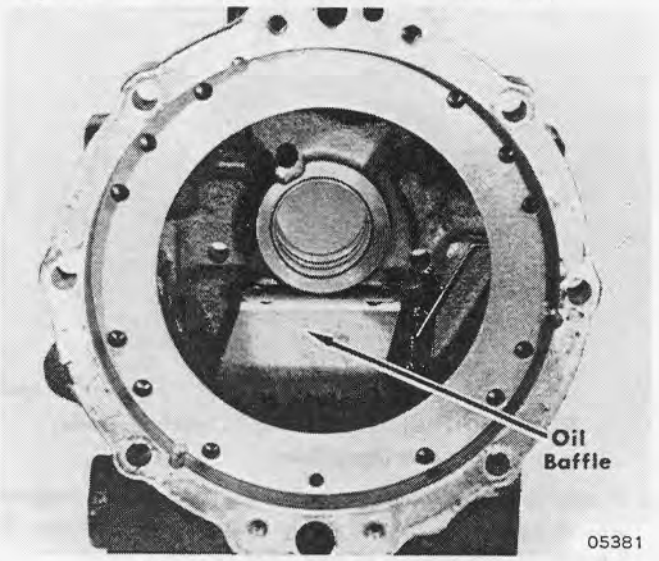


Figure 4. Installing Oil Baffle

3. Support transmission housing with wood support on output shaft end. Install thrust washer with tang in groove of housing.
4. Install pinion cage and output shaft assembly in transmission housing.
5. Place ring gear on a clean surface with external teeth up, as shown in Figure 5.
6. Remove all dirt and solid particles from shoulder inside gear formed by top of internal helical gear. (Figure 5)
7. With smoothly ground face in upward position, install clutch pressure plate (rear) in ring gear as shown in Figure 5. Assembly is complete when clutch pressure plate is firmly and squarely seated on shoulder at bottom of internal splines.

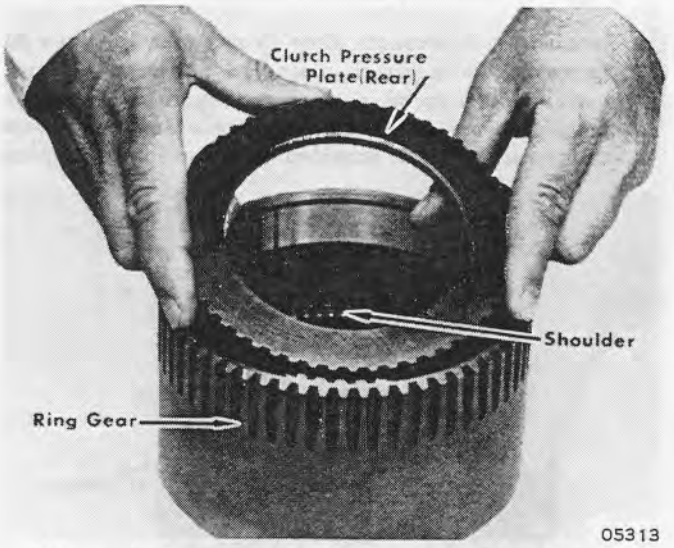


Figure 5. Installing Clutch Pressure Plate (Rear)

8. For Model 71C, lubricate 5 clutch inner plates and 4 outer clutch plates, arrange and assemble as shown in Figure 6.
   For Model 72C, lubricate 7 clutch inner plates and 6 center clutch plates.

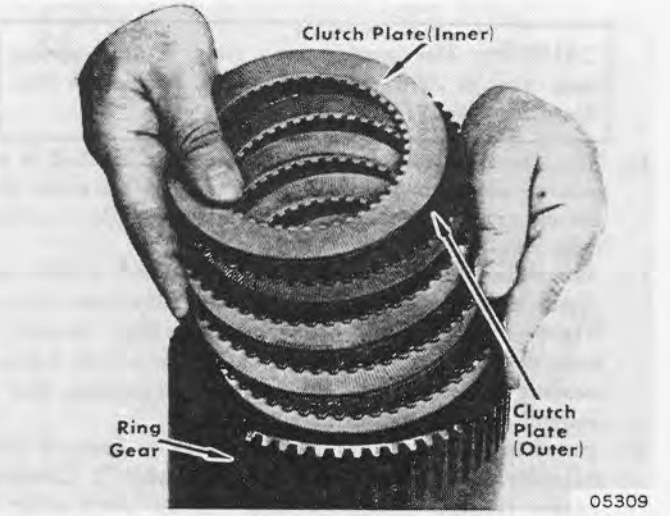


Figure 6. Installing Forward Clutch Plates

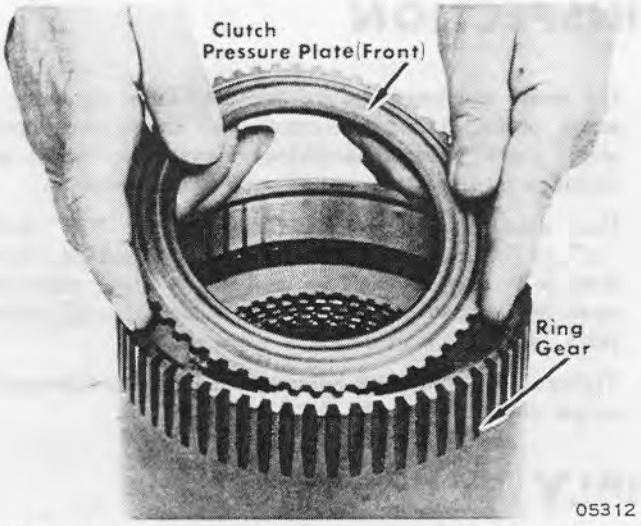


Figure 7. Installing Clutch Pressure Plate (Front)

9. Install clutch pressure plate (front) with flat face down in contact with clutch plate, as shown in Figure 7.
10. Install clutch spring snap ring. (Figure 8) Assembly is complete when snap ring is squarely and firmly seated on internal shoulder provided on top of internal splines.

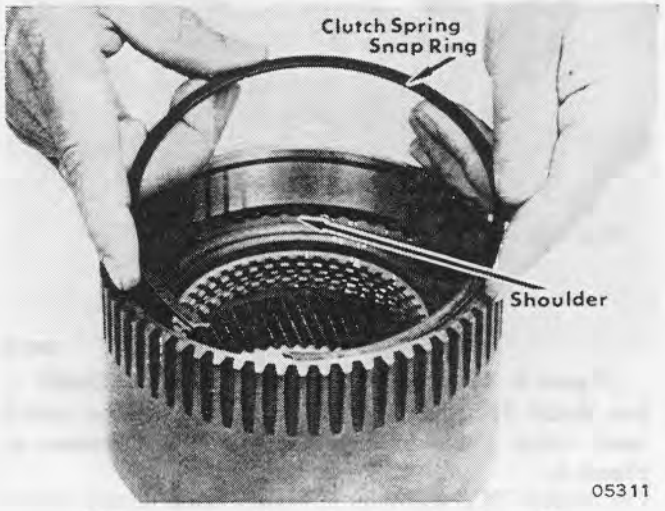


Figure 8. Installing Clutch Spring Snap Ring

CAUTION: Use proper snap ring. Clutch spring snap ring is .090" to .093" thick and has a free diameter of 5-19/32" + 1/16".

11. With concave side of clutch spring down, install in ring gear as shown in Figure 9. Assembly is complete when clutch spring is seated firmly and squarely on clutch snap ring.
12. Assemble clutch spring bearing ring and a lubricated clutch sealing ring on forward clutch piston as shown in Figure 19 in "Disassembly", preceding. Inspect inside diameter of forward clutch piston which contacts sealing ring. Remove all burrs or scratches and lubricate before assembly.
13. Install a well-lubricated sealing ring in forward clutch cylinder. (Figure 18 in "Disassembly") Lubricate entire forward clutch cylinder before continuing assembly.
14. After aligning assembled forward clutch piston squarely on assembled forward clutch cylinder, press clutch

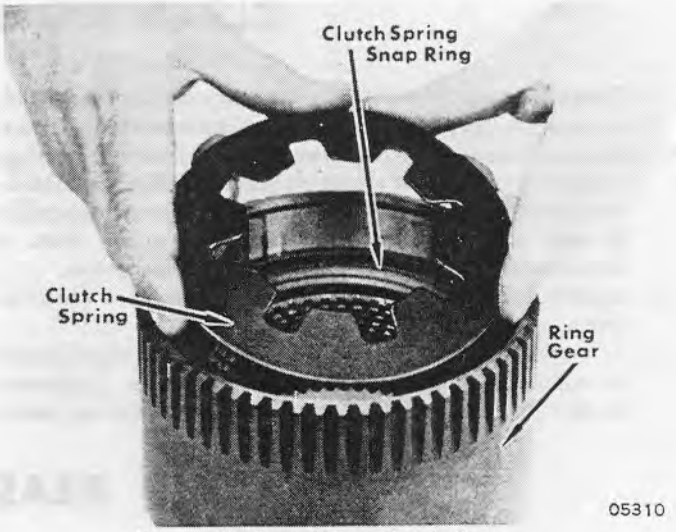


Figure 9. Installing Clutch Spring

piston into forward clutch cylinder. (Figure 10) This is a hand assembly and should not require pounding by hammer or pressing on arbor press. Assembly is complete when piston "bottoms" in forward clutch cylinder.

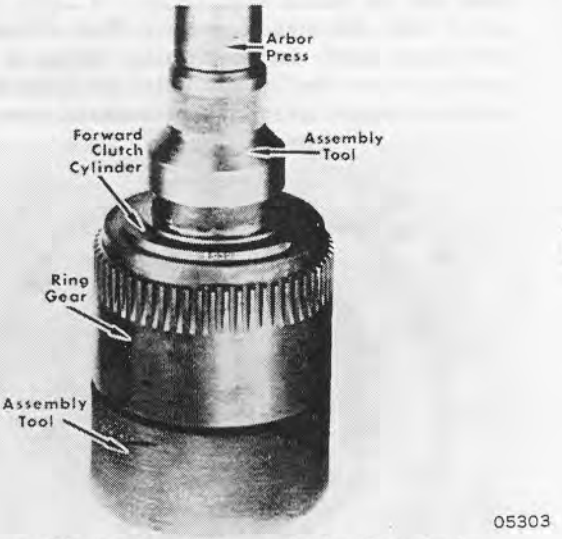


Figure 10. Pressing Forward Clutch Cylinder into Ring Gear

15. Place clutch plate assembly on a suitable support which has been placed on an arbor press. (Figure 11) Center clutch spring in ring gear.
16. Place clutch and shaft assembly into open top of clutch plate assembly. (Figure 11) Place a suitable assembly tool squarely on top of forward clutch cylinder and press down with arbor press until forward clutch cylinder is firmly seated on snap ring, and groove for snap ring is fully exposed. Check by looking into rear of ring gear to be sure that clutch bearing ring is properly assembled on forward clutch piston.
17. While maintaining load from arbor press, assemble ring gear snap ring. (Figure 16 in "Disassembly") Tap ring while in place to ensure full seating of ring in groove.

CAUTION: Use proper snap ring. Ring gear snap ring is .074" to .078" thick and has a free diameter of 5-7/8" + 1/16".

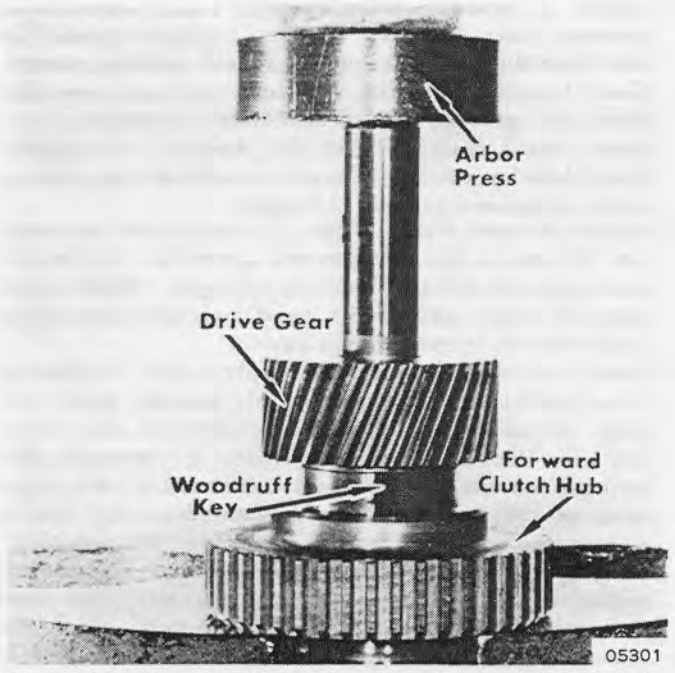


Figure 11. Pressing Drive Gear into Forward Clutch Hub

18. Place forward clutch hub on a suitable support placed on an arbor press in position shown in Figure 11. Assemble woodruff key in keyway provided on drive gear. (Figure 11) Lubricate outside diameter of drive gear on area which presses into forward clutch hub.
19. Install drive gear and woodruff key squarely into forward clutch hub, being careful to align key with mating keyway in forward clutch hub. (Figure 11) Press drive gear into forward clutch hub until gear "bottoms" on face of forward clutch hub, and groove for snap ring is fully uncovered.
20. Invert forward clutch assembly and install snap ring in groove provided. (Figure 11) Tap ring after assembly with suitable tool to ensure full seating in groove.
21. Install 2 forward clutch sealing rings in grooves provided on drive gear. (Figure 12) After installing rings in groove, hook ends and turn rings to ensure freedom of rotation.

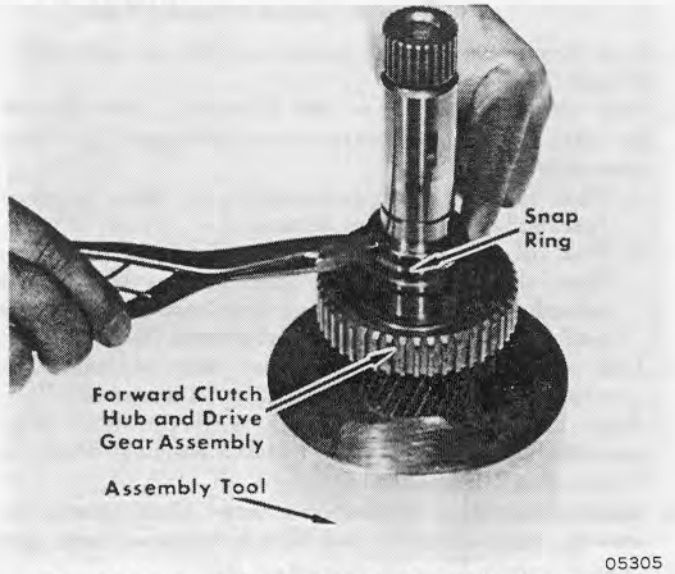


Figure 12. Installing Forward Clutch Sealing Rings on Drive Gear

22. With drive gear and clutch hub in assembly tool as shown in Figures 11 and 12, place ring gear and forward clutch assembly over drive gear. (Figure 15 in "Disassembly")
23. Lower ring gear and clutch assembly until internal teeth of clutch plates begin to engage teeth on forward clutch hub. Rotate ring gear to align teeth of plates with teeth on clutch hub. DO NOT force ring gear, or teeth will be damaged. When ring gear and clutch are in correct position, rear end of ring gear should be against assembly tool or "flush" with rear thrust face of drive gear. (Figure 13) DO NOT remove drive gear and clutch assembly from assembly tool or move drive gear forward until Steps 24, 25 and 26 are completed. Any movement of drive gear forward will disengage clutch plates from clutch hub and move sealing rings out of position.

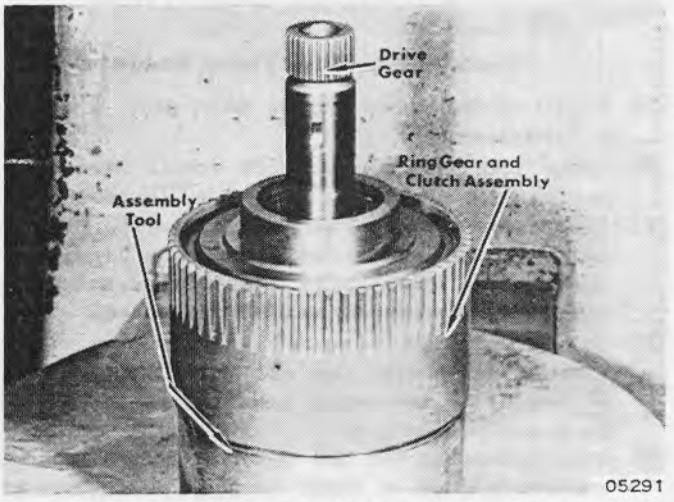


Figure 13. Assembling Ring Gear and Clutch Assembly on Drive Gear

24. Place aligned parts and assembly tool in place on arbor press. Place bearing over protruding drive gear and squarely into bore at front of forward clutch cylinder. Press bearing down with arbor press until bearing is fully seated on shoulder, and snap ring grooves in front of bearing are exposed. (Figure 14)

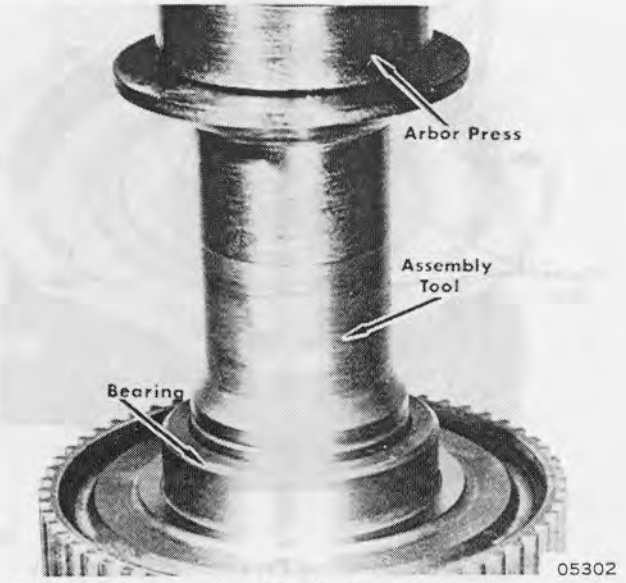


Figure 14. Pressing Clutch Bearing In Place

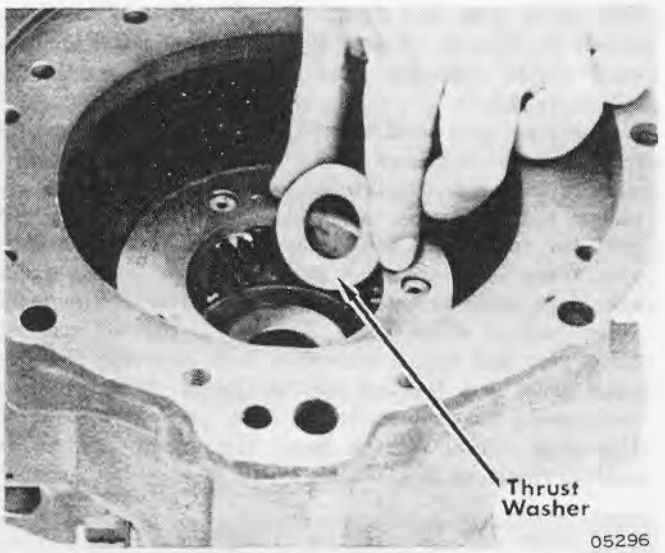


Figure 15. Installing Thrust Washer

25. Install external snap ring on drive gear. (Figure 14 in "Disassembly")
26. Using Snap Ring Pliers J-5586, install internal snap ring in clutch cylinder. (Figure 15 in "Disassembly")
27. Place transmission housing on a smooth, clean surface in upright position as indicated in Figure 15. In this position, rear face of rear coupling will provide sufficient base to enable assembly to proceed.
28. Coat drive gear thrust washer with petroleum jelly and assemble into pinion cage and output shaft assembly. (Figure 15) Center washer carefully over bore provided for on rear of drive gear.
29. After lubricating rear end of drive gear and checking centered position of thrust washer, install drive gear and clutch assembly into case and pinion cage and output shaft assembly. (Figure 13 in "Disassembly") Exert care and proper centering at this point to prevent damage to bushings when rear diameter of drive gear enters output shaft.

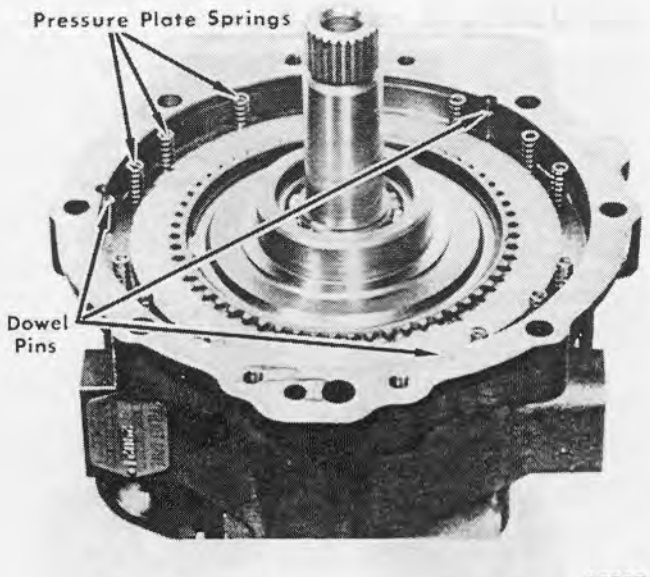


Figure 16. Installing Pressure Plate Springs and Dowel Pins

30. Install 12 pressure plate springs in holes provided in reverse clutch cavity. (Figure 16) Holes should be free from dirt, and all springs should be firmly seated.
31. Coat 3 dowel pins with petroleum jelly and assemble them in 3 grooves provided at outside diameter of reverse clutch cavity. (Figure 16) Assembly is complete when dowel pin is firmly seated on end and into groove, as far as groove contour will permit.
32. Install reverse clutch plates, (2 bronze and one steel for 71C Series and 3 bronze and 2 steel for 72C Series) over exposed splined teeth of ring gear. Clutch plate must be firmly and evenly seated on case face which forms rear of reverse clutch cavity.
33. Install reverse clutch pressure plate with 12 holes in down position. Align cast slot in pressure plate with large oil hole in front face of transmission case. (Figure 12 in "Disassembly") Since 12 pressure plate springs are not evenly spaced, slot and oil hole alignment are required to locate pressure plate with relation to pressure plate springs. (Figure 12 in "Disassembly") A properly assembled reverse pressure plate will appear as shown in Figure 17. If pressure plate does not drop down to position, approximately flush with transmission case front face, check 3 dowel pins for possible misalignment.

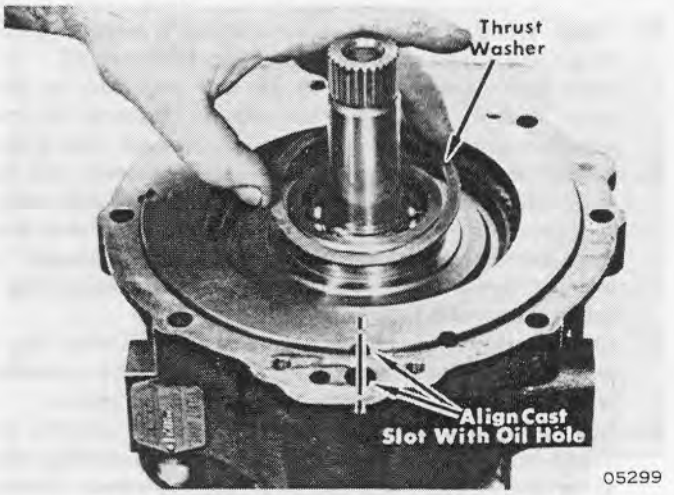


Figure 17. Installing Thrust Washer and Reverse Clutch Pressure Plate

34. Coat thrust washer with petroleum jelly and assemble. (Figure 17)
35. After checking adaptor for the following, place adaptor on clean surface in position shown in Figure 7 in "Disassembly":
    a. That needle bearing assembly is clean, properly installed and free from damage.
    b. That oil passages are free from dirt and obstruction.
    c. That the reverse clutch cavity outer wall has a smooth, clean surface, free from scratches or burrs and coated generously with petroleum jelly.
36. Coat sealing ring with petroleum jelly and install in groove of adaptor hub. (Figure 10 in "Disassembly")
37. After lubricating sealing ring with petroleum jelly, assemble in groove of reverse clutch piston as shown in Figure 9 in "Disassembly".
38. Examine inside diameter of reverse clutch piston for smooth, clean surface, free from scratches or burrs and coated generously with petroleum jelly.
39. Place reverse clutch piston on adaptor. (Figure 18) Press down on reverse clutch piston while pulling a

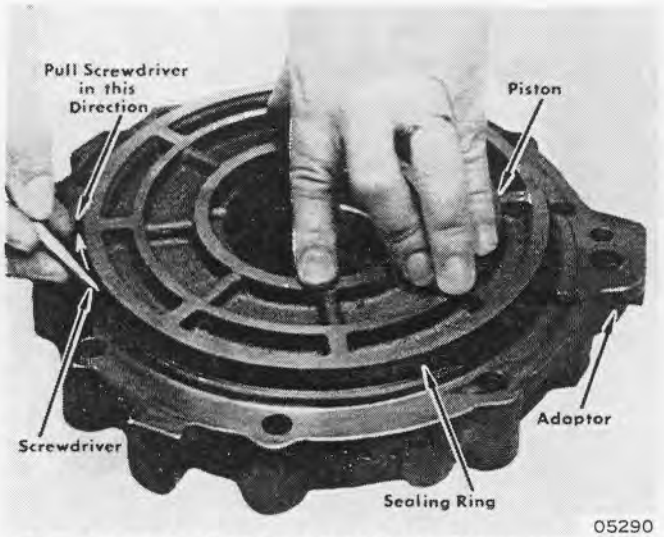


Figure 18. Installing Reverse Clutch Piston in Adaptor

smooth, clean screwdriver blade around exposed portion of sealing ring. This will aid chamfered bore in adaptor to compress sealing ring into groove in outside diameter of piston. Assembly can be completed by using hand pressure until piston has "bottomed" in reverse clutch cavity. Exposed face of clutch piston should be flush with adjacent surrounding surface on adaptor when assembly is completed.

40. Coat exposed front of transmission case with petroleum jelly and assemble case and adaptor gasket. (Figure 8 in "Disassembly")
41. Align oil holes as indicated in Figure 8 in "Disassembly", then lower reverse clutch piston and adaptor assembly squarely onto input gear and transmission case.
42. When shoulder on rear of adaptor has entered mating bore in reverse clutch cavity (located in front of transmission case) and check of gap between case and adaptor indicates that adaptor is squarely in place, install 4 cap screws. (Figure 7 in "Disassembly") Adaptor now can be pulled down squarely, until contact with case is made, by alternately tightening cap screws a small amount and checking frequently for binding. When adaptor is pulled down as far as possible, tighten 4 screws to 27 to 37 lbs. torque.
43. After installing new oil seal, lubricate pump housing with proper transmission oil and place as shown in Figure 19. Install lubricated driven pump gear with identification mark as shown in Figure 20.

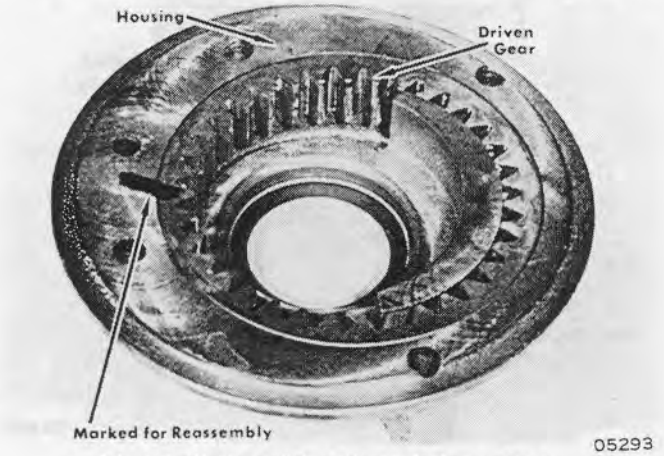


Figure 19. Installing Pump Driven Gear

44. Lubricate and install front pump gasket. (Figure 21)
45. Install woodruff key. (Figure 19)
46. Install pump drive gear on input shaft, with woodruff key slots in drive gear mating with woodruff key on the input shaft. (Figure 19)

NOTE: Assemble the 2 pump gears so that the same gear faces are matched with the machined face of the pump housing as found at disassembly. Marks should have been applied at disassembly to insure proper reassembly.

47. With pump driven gear properly installed in front pump housing, assemble housing and pump driven gear squarely over protruding input shaft. A slight rotation of pump driven gear will allow engagement of pump gear teeth. (Figure 21)

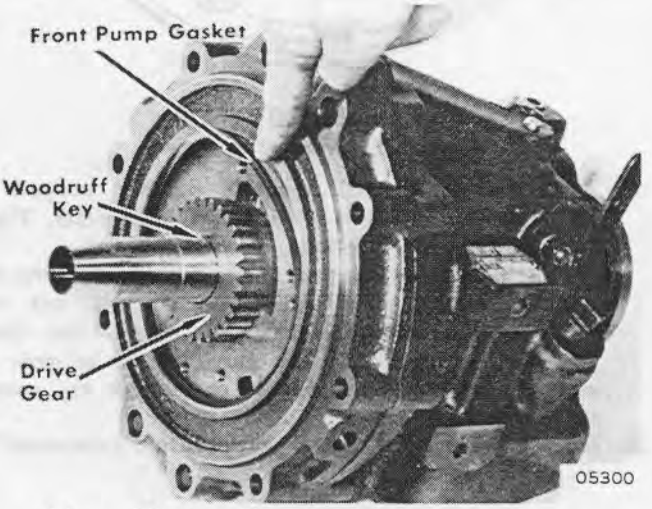


Figure 20. Installing Pump Drive Gear Key and Front Pump Gasket

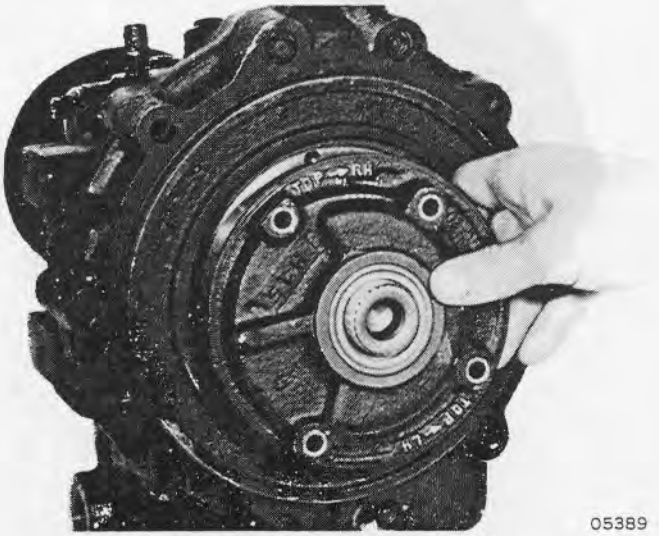
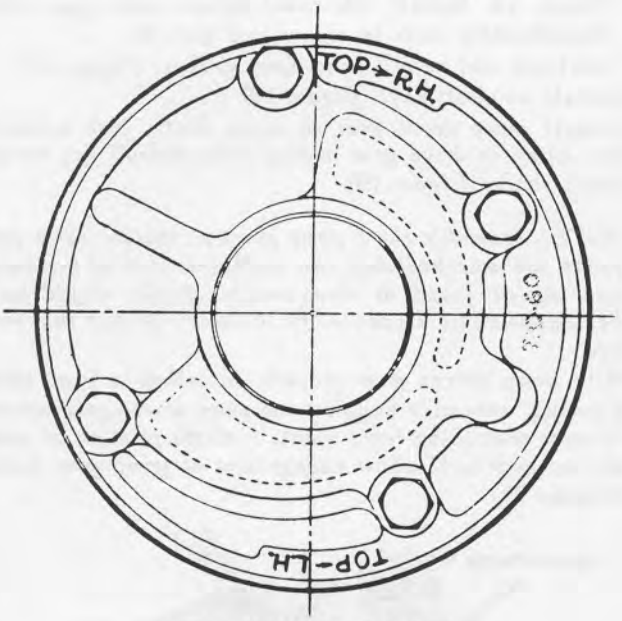


Figure 21. Installing Front Pump

NOTE: Wrap input shaft spline with tape to protect rubber lip on seal.

48. Orient pump mounting bolt holes and arrow (indicating direction of rotation) to correspond with direction of rotation required by engine, (Figure 22) If not installed for proper rotation, pump will not produce oil pressure to operate transmission when engine is started.



LEFT HAND ROTATION

Figure 22. Orientation Marks

49. With pump assembled squarely against adaptor and pump gasket, install 4 5/16-18 hex head bolts. Tighten hex head bolts evenly to torque of 17-22 lbs.
    Check freedom of rotation of pump gears in pump housing by rotating input shaft. If pump will not rotate freely, disassemble pump and check for foreign material in pump. Any dirt particles on adaptor face will cock pump when mounted on adaptor and cause it to seize.
50. Install "O" ring on end of control valve. Lubricate "O" ring with petroleum jelly.

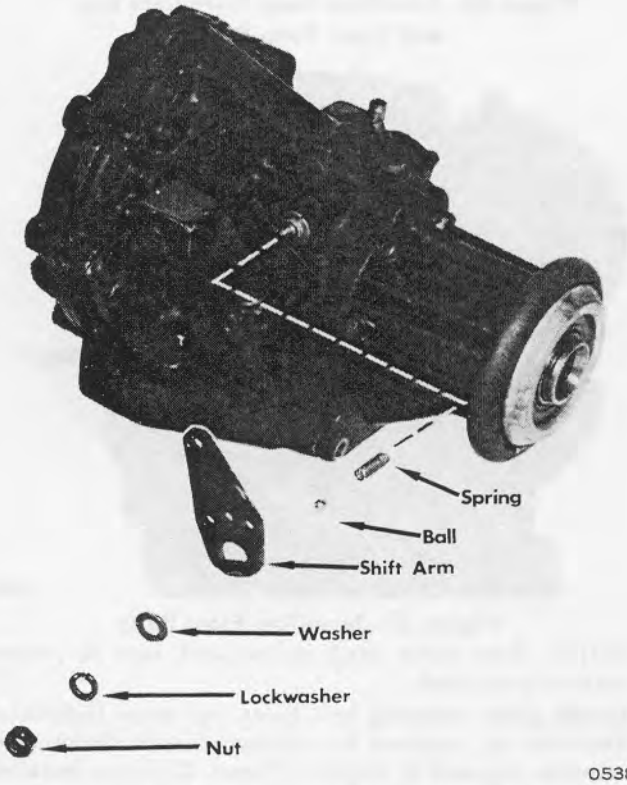


Figure 23. Assembly of Shift Lever

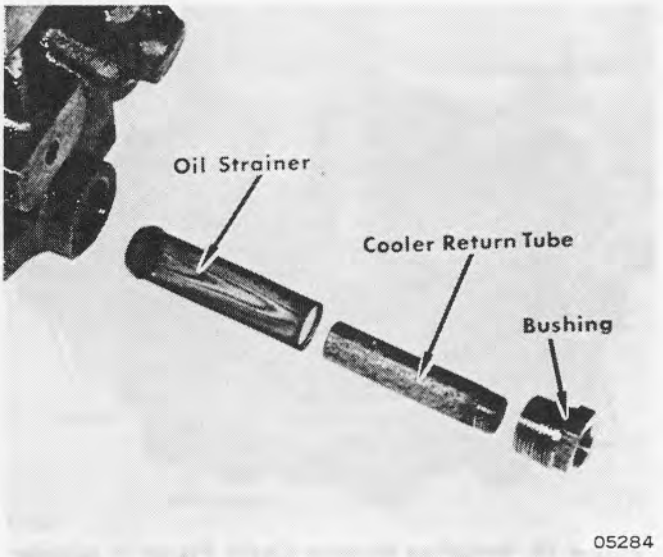


Figure 24. Installing Oil Strainer and Cooler Return Tube

51. Place valve and spring assembly (threaded end first in side of transmission case. (Figure 4 in "Disassembly")
52. To ensure neutral positioning of valve and easier assembly of lever, align .369-.376 width slot in valve with bottom 1/4-20 bolt hole in valve cover face of case. (Figure 4 in "Disassembly")
53. Assemble valve cover gasket, valve cover, lockwashers and hex head bolts. Torque hex head bolts to 8-11 ft. lbs.
54. Coat spring, ball and arm with Quicksilver Anti-Corrosion Oil (C-92-45134-12). Assemble shift lever and related parts in order shown in Figure 23. Torque hex nut 8-11 ft. lbs. Rotation of valve and spring assembly thru forward, neutral and reverse positions should require no more than fingertip effort. If valve binds in rotation, remove and inspect.

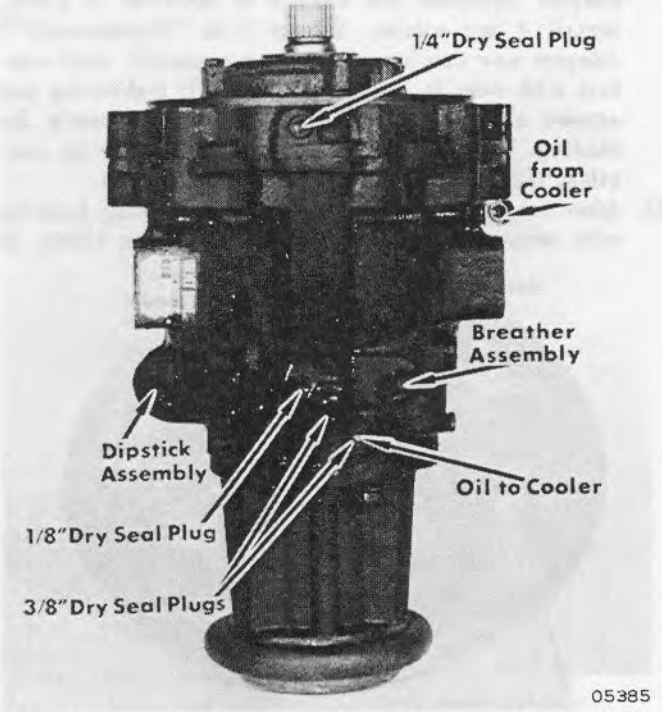


Figure 25. Installation of Pipe Plugs

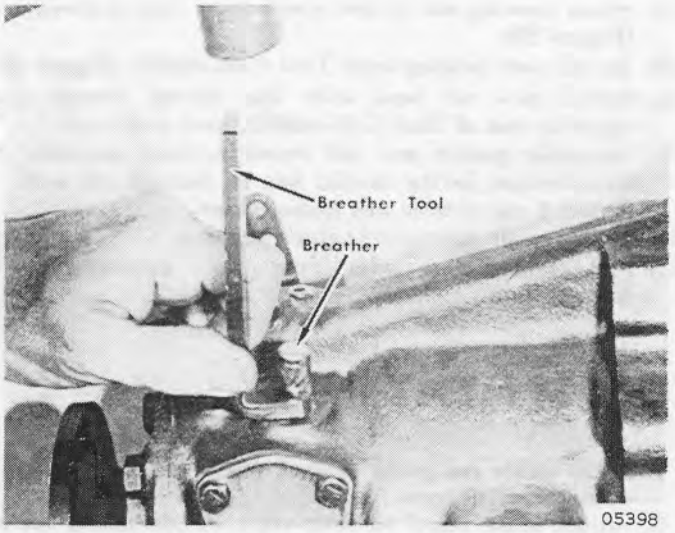


Figure 26. Installation of Breather Assembly

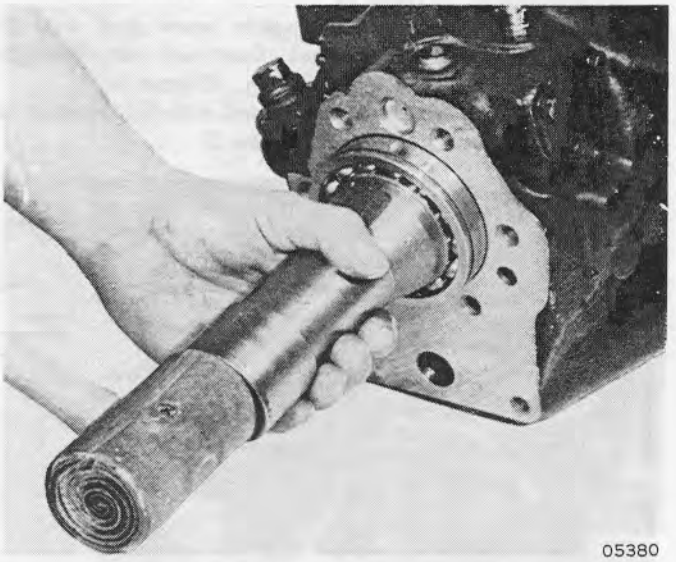


Figure 27. Installing Bearing and Shaft

Figure 28. Removing Tail Stock Oil Seal

Figure 29. Removing Tail Stock Bearing

55. Assemble oil strainer assembly, cooler line return bushing and cooler return tube assembly in order shown in Figure 24. Screen end of oil strainer assembly should be approximately ½" below face of case when assembly is correctly installed.
    Tighten cooler line return and oil drain bushing to recommended torque of 25-35 ft. lbs.
56. Install dipstick assembly and dry seal plugs (if removed). (Figure 25)
57. If breather assembly was removed, use assembly tool (Figure 26) and install new breather assembly. DO NOT hammer on top of breather assembly.
58. On engine coupling, check welch plug (located in center of coupling) for tightness. If loose, remove welch

Figure 30. Installing Tail Stock Bearing

plug, clean surfaces, coat surfaces with Loctite and drive in new welch plug. Check oil seal. Replace if damaged.

59. Inspect coupling bearing for wear or damage. To replace, remove snap ring and press bearing off coupling. Install bearing on engine coupling. Install snap ring.
60. Install bearing coupler assembly on output shaft spline. Tap coupling with mallet to seat bearing. (Figure 27)
61. If tail stock oil seal and bearing require replacement remove oil seal with appropriate tool. (Figure 28) Insert tool between bearing and seal and pry out seal.
62. Press bearing out of tail stock with Tool C-91-32325. (Figure 29)
63. Install new bearing with Tool C-91-48630. (Figure 30)
64. Install new oil seal with lips facing inward. Use opposite end of Tool C-91-48630. used previously.
65. Assemble gasket and tail stock housing assembly to transmission, being careful not to damage oil seal. Install 8 cap screws and lockwashers.
66. Install guide spring to engine coupling.
67. Fill transmission with Type "A" automatic transmission fluid.

SHIFT CABLE ADJUSTMENT

1. Place remote control handle in full forward position.
2. Place transmission in forward gear by moving shift cable lever to the right until detent ball (located behind transmission shift lever) is centered in rear hole in transmission shift lever. (Figure 1)

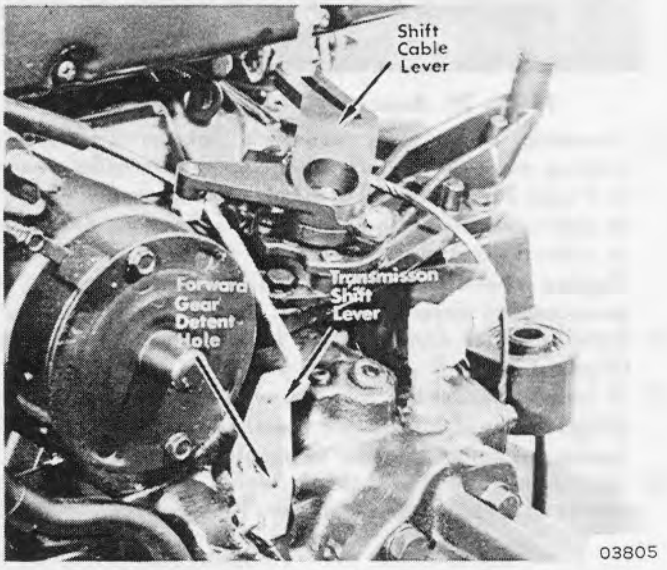


Figure 1. Transmission Shift Lever Position - Forward Gear

3. Remove roll pin, which passes thru knurled pin in cable end guide, and remove knurled pin and spring from end guide.
4. Place cable end guide on stud which is located in shift cable lever. (Figure 2)
5. Adjust brass barrel on shift cable so that barrel can be placed on anchor stud without disturbing shift cable lever position. (Figure 2)
6. Fasten end guide to shift cable lever stud with flat washer and nut. Tighten nut, then back nut off slightly to allow end guide to pivot freely. (Figure 2)
7. Fasten brass barrel to anchor stud with flat washer and nut. Tighten nut securely. (Figure 2)

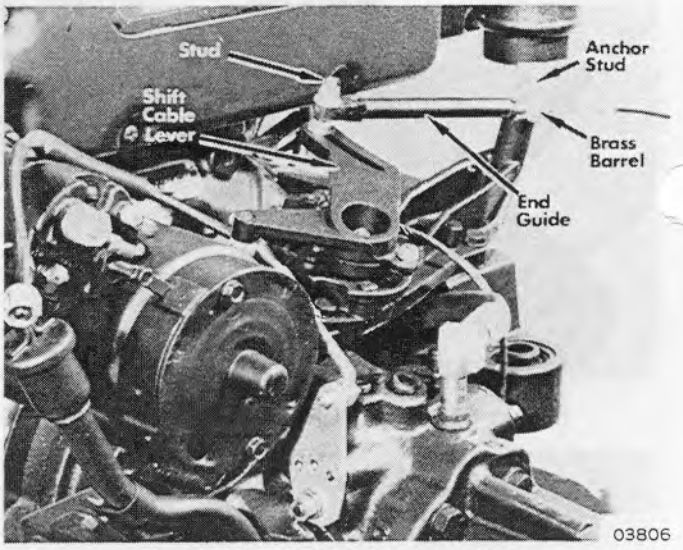


Figure 2. Shift Cable Installed

TOOLS

The assembly tool drawings (shown on this page) are included to illustrate how these tools may be made. Most will provide convenience in assembling and disassembling the transmission, but their functions may be performed by the substitution of other objects.

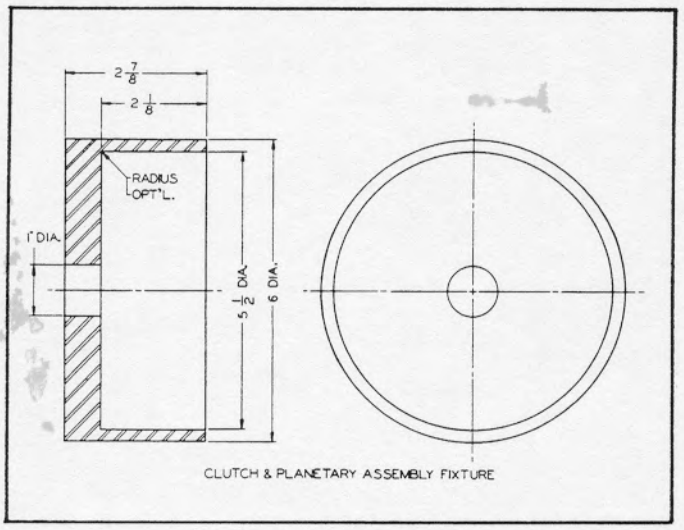


Figure 3. Drawing No. 1

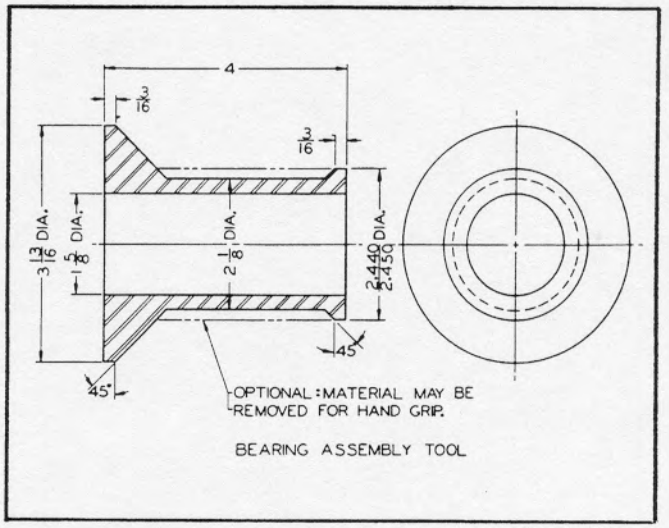


Figure 4. Drawing No. 2

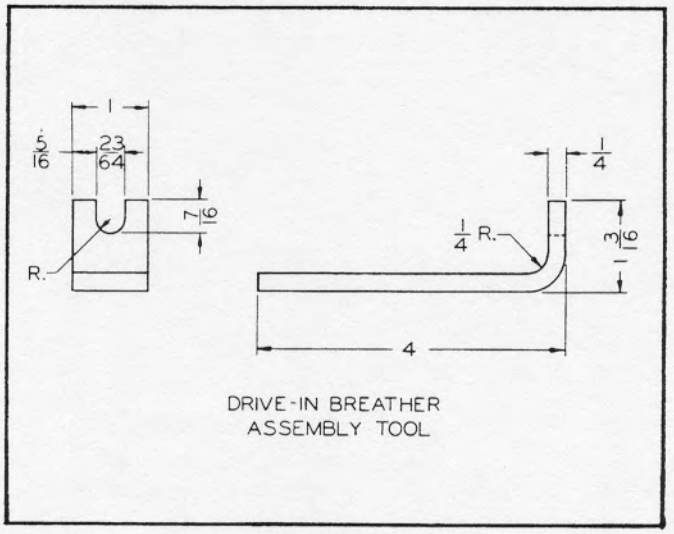


Figure 5. Drawing No. 3

All "J" (Special) Tools Listed Herein May Be Purchased from:

Kent-Moore, Inc.
28635 Mound Road
Warren, Michigan 48089

SECTION 6 - DRIVE SYSTEMS

MERCRUISER

PART F - MERCRUISER II-TR DRIVE UNIT

MERCURY MARINE

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MERCRUISER 225-255 II-TR DRIVE UNIT

GENERAL SERVICE RECOMMENDATIONS

Threaded parts are right hand (RH), unless otherwise indicated. Drive unit should be completely disassembled, inspected and cleaned, if either gear housing or drive shaft housing has indicated a failure.

All bearings should be inspected for pits, wear, dirt and excessive looseness. Keep a record of shim amounts and location. To prevent corrosive action during reassembly, apply Anti-Corrosion Grease (C-92-45134) to all "O" rings and housing mating surfaces. To ease installation of shafts, apply Multipurpose Lubricant (C-92-49588) to the lip of all oil seals.

To prevent oil leakage, apply Loctite Type "A" (C-92-32609-1) on outside diameter of all metal case oil seals. When using Loctite on oil seals or threads, surfaces must be clean and dry.

Refer to Section 8, "Specifications", for all torque specifications.

Be sure to follow shimming instructions closely. Gears must be mounted to correct feeler gauge reading and correct gear backlash to avoid noisy performance and premature failure. Bearing preload must be within specifications, or bearing failure may result.

A suitable mandrel for pressing tapered roller bearings on shafts and gears can be obtained from the old bearing. Cut outer cage off inner race with hack saw. (Figure A) Remove cage and bearing rollers. Inner race (used as a mandrel) will apply pressing force to inner race of new bearing without damaging bearing cage, rollers or races. Remove bearings from gears or shafts only if replacement is necessary.

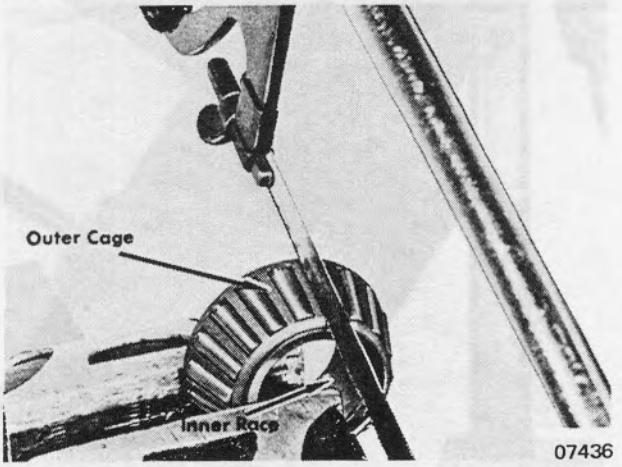

Figure A. Cutting Outer Cage to Obtain Mandrel

GEAR HOUSING REMOVAL

1. Remove complete drive unit from bell housing as in "Drive Shaft Housing Removal", Section 2. Drain gear lubricant.
2. Remove propeller and trim tab.
3. Remove allen head screw located under trim tab. Remove 7 nuts and separate gear housing from drive shaft housing

Figure 1. Draining Lubricant

GEAR HOUSING INSTALLATION

NOTE: If gear housing, drive shaft housing, lower drive shaft or lower drive shaft components HAVE NOT been replaced, start installation procedures at step No. 5.

1. Set preload on lower drive shaft tapered roller bearings by over-shimming (.060 or more) lower drive shaft bearing cup (located in drive shaft housing). (Figure 2) Connect gear housing to drive shaft housing with 7 nuts. Do not tighten nuts at this time.

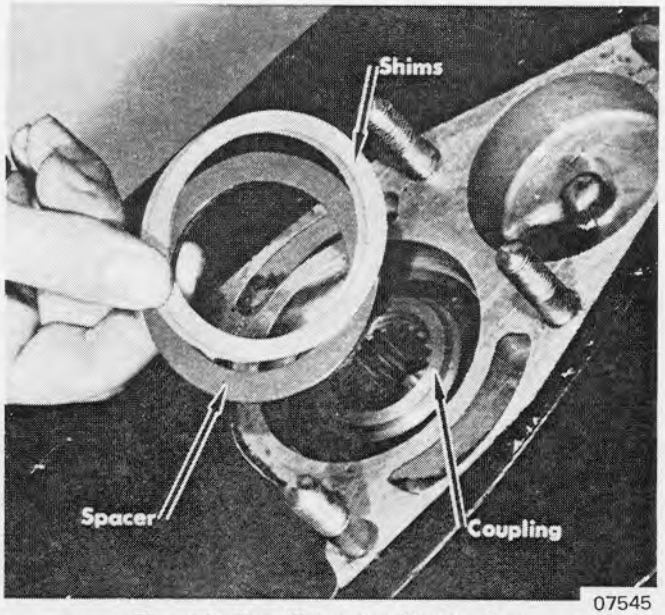

Figure 2. Over-Shimming Bearing Cup

2. Use preload torque chart (Section 8, "Specifications") and locate drive shaft housing over-all bearing preload torque (determined in "Drive Shaft Housing Reassembly", following) on top line. Locate propeller shaft bearing preload torque (determined in "Gear Housing Reassembly", following) on left side column. Follow down from drive shaft housing preload torque and across from propeller shaft preload torque until they cross. (Refer to example shaded area on chart, Section 8, "Specifications".) The 2 figures in block (located on preload chart) are upper and lower limits of drive unit over-all bearing preload torque, as measured from propeller shaft.
3. Tighten gear housing to drive shaft housing nuts evenly to maintain an even gap between housings until bearing preload torque, measured at propeller shaft, is within limits determined from chart. (Figure 3)
4. Measure gap between housings on both sides of drive shaft (Figure 3) and take an average of these readings. Remove gear housing and subtract that amount of shims from under (over-shimmed) bearing cup, then reinstall cup.
5. Install trim tab allen head screw (if removed) in hole provided in gear housing.
6. Install "O" ring around lower drive shaft bearing cup on drive shaft housing and "O" ring in groove which is

provided around oil recirculating passage in gear housing.

7. Connect gear housing to drive shaft housing with 7 nuts. Tighten evenly.
8. Install one allen head screw located in trim tab cavity.
9. Install trim tab and trim tab screw access hole plug. Replace propeller and propeller components.

CAUTION: Propeller nut must be locked with tab washer to retain propeller.

10. Fill drive unit with fresh Super-Duty Gear Lubricant (C-92-52650 Tube, C-92-52655 Can, C-92-52645 37-lb. pail) as illustrated in "Stern Drive Unit Installation", Section 2.

Figure 3. Installing Gear Housing

GEAR HOUSING DISASSEMBLY - RIGHT HAND ROTATION

IMPORTANT: Follow "General Service Recommendations", preceding.

1. Mount gear housing assembly on Repair Stand (C-91-33750) with Adaptor (C-91-60524A _).
2. Straighten locking tab and loosen threaded retainer with Retainer Tool (C-91-54873). (Figure 1) Remove retainer and tab washer.

Figure 1. Removing Threaded Retainer

3. Remove bearing carrier with Slide Hammer (C-91-34569A1) and Bearing Carrier Puller (C-91-45086A1). (Figure 2) Be careful not to lose carrier alignment key.

Figure 2. Removing Bearing Carrier

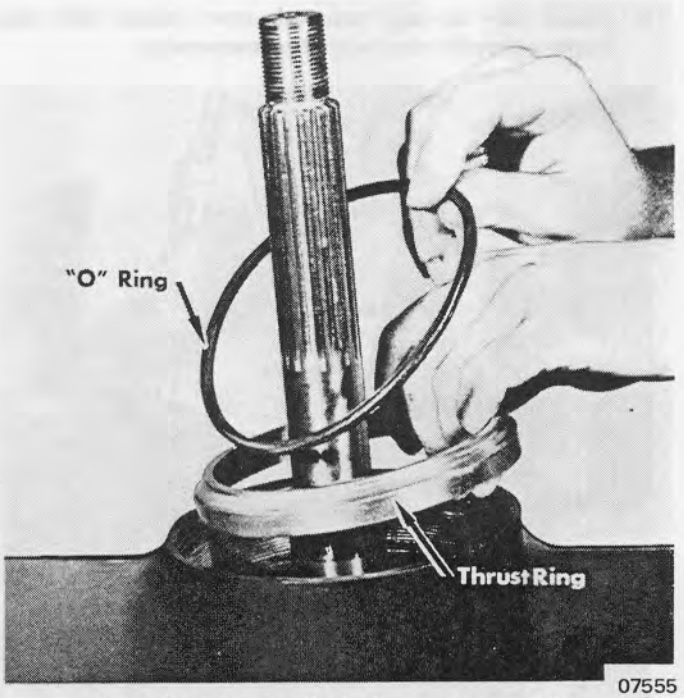

Figure 3. Removing "O" Ring and Thrust Ring

NOTES: For disassembly and reassembly of bearing carrier, refer to "Bearing Carrier", following.

For left hand rotation propeller shaft removal, refer to "Left Hand Rotation Variations", following.

4. Lift propeller shaft straight up (about 3 or 4 inches) to unseat thrust ring and "O" ring. Set propeller shaft back into its normal running position in gear housing and lift the "O" ring and thrust ring out of gear housing. (Figure 3)

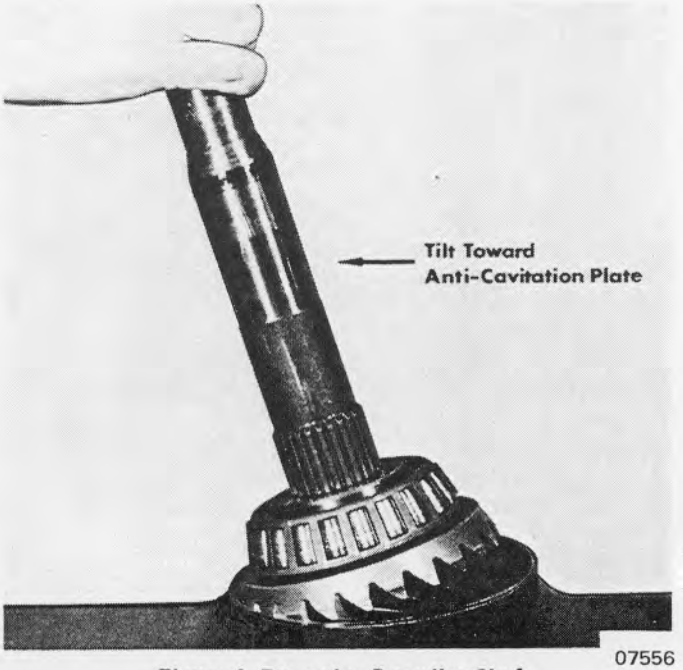

Figure 4. Removing Propeller Shaft

5. To prevent damaging propeller shaft bearing on pinion gear, tilt propeller end of shaft toward anti-cavitation plate while removing shaft from housing. (Figure 4) Remove shims from shoulder in gear housing.

   NOTE: Refer to disassembly and reassembly of propeller shaft, following.

6. Reinstall carrier retainer nut to protect threads in housing. Use Drive Shaft Socket Tool (C-91-63620A1) and remove pinion gear nut and washer. (Figure 5)

07551

Figure 5. Removing Pinion Gear Nut

7. Thread Drive Shaft Puller Tool (C-91-63616) into end of drive shaft. Use Slide Hammer Tool (C-91-55919) to separate drive shaft from pinion gear (Figure 6), then remove shaft and gear.

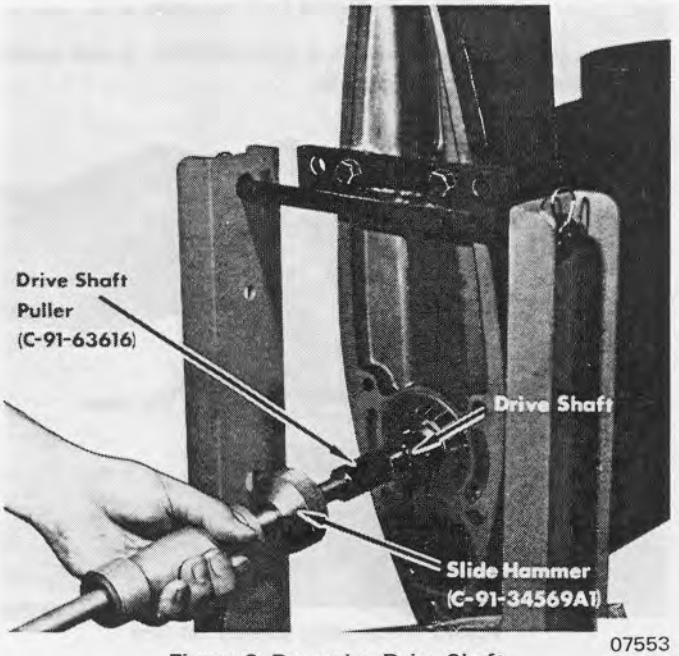

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Figure 6. Removing Drive Shaft

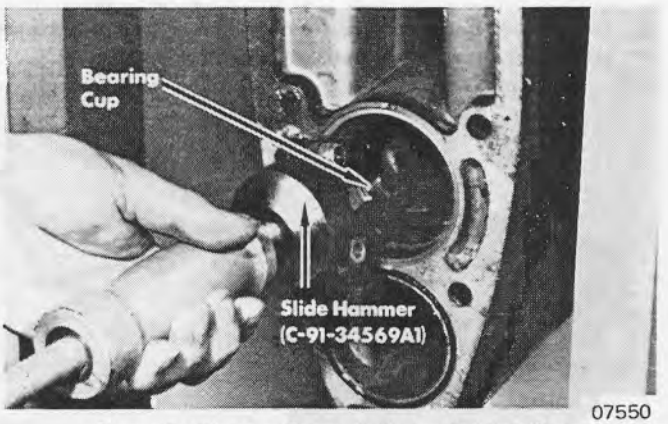

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Figure 7. Remove Tapered Roller Bearing Cup

NOTE: Refer to disassembly and reassembly of drive shaft, following.

8. Using Slide Hammer Tool (C-91-34569A1), remove small drive shaft tapered roller bearing cup from gear housing (Figure 7) and remove shims. Using same procedure, remove propeller shaft tapered roller bearing cup from gear housing and remove shims.

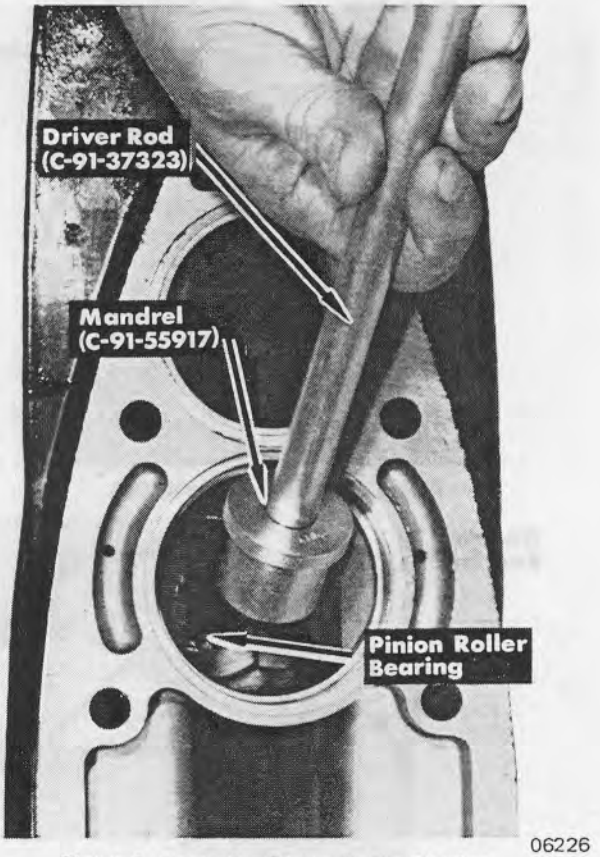

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Figure 8. Removing Pinion Roller Bearing

9. Remove drive shaft pinion roller bearing from gear housing with Driver Rod Tool (C-91-37323) and Mandrel Tool (C-91-55917). (Figure 8)

10. Remove "O" ring from gear housing oil recirculating passage.

BEARING CARRIER DISASSEMBLY

1. Using Slide Hammer Tool (C-91-34569A1), remove tapered roller bearing cup from bearing carrier. (Figure 1)

Figure 1. Removing Bearing Cup

2. Using Sleeve Tool (C-91-55919) and Driver Rod Tool (C-91-37323), remove needle bearing and 2 oil seals from carrier. (Figure 2)

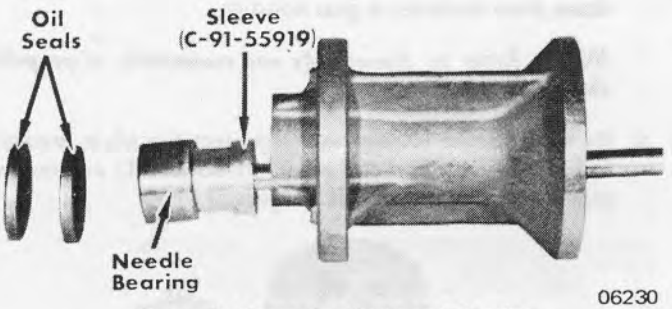

Figure 2. Removing Seals and Bearing

NOTE: Seals can be removed separately with Slide Hammer (C-91-34569A1).

BEARING CARRIER REASSEMBLY

1. Install tapered roller bearing cup in bearing carrier with Driver Tool (C-91-63626). (Figure 3)

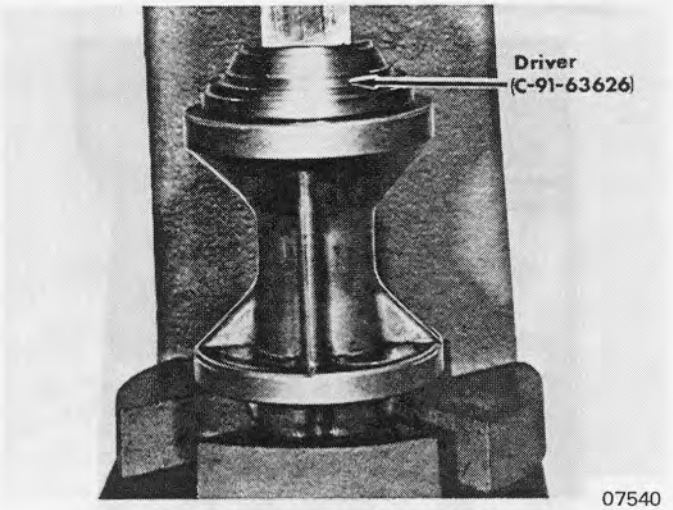

Figure 3. Installing Bearing Cup

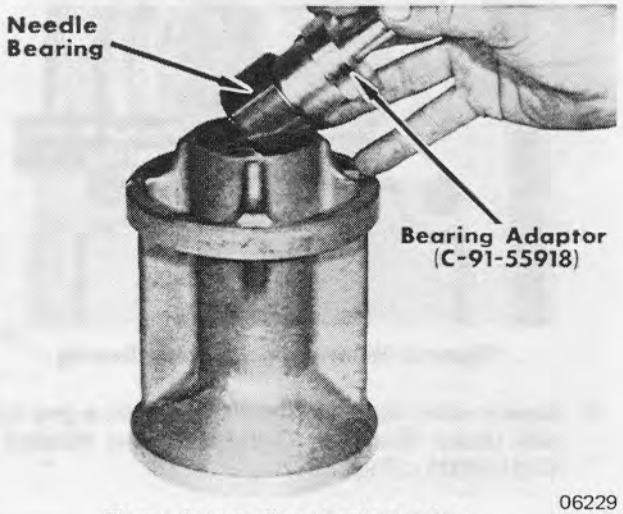

Figure 4. Installing Needle Bearing

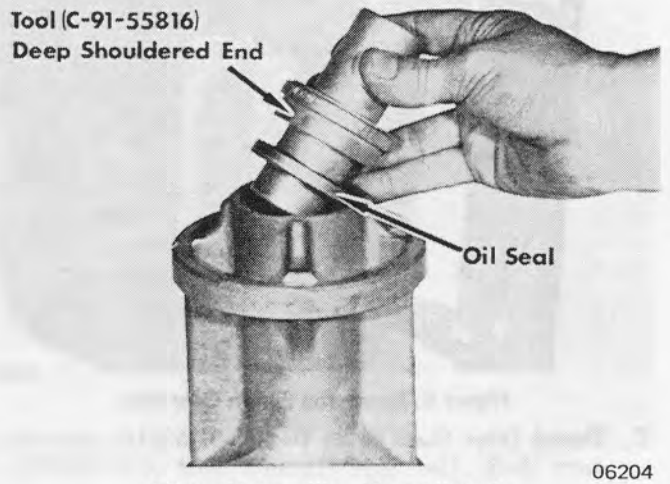

Figure 5. Installing First Oil Seal

2. Using Bearing Adaptor Tool (C-91-55918), install needle bearing in carrier. (Figure 4)

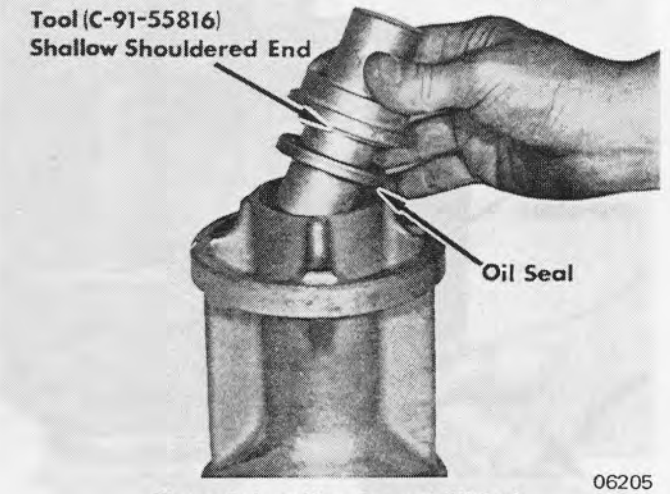

Figure 6. Installing Second Oil Seal

3. Use deep shouldered end of Driver Tool (C-91-55816) to install first oil seal with lip facing in. (Figure 5)
4. Use shallow shouldered end of Driver Tool (C-91-55816) to install second oil seal with lip facing out. (Figure 6)
5. Fill space between oil seals with Multipurpose Lubricant (C-92-49588).

PROPELLER SHAFT DISASSEMBLY - RIGHT HAND ROTATION

NOTE: For left hand rotation propeller shaft differences, refer to "Left Hand Rotation Variations", following.

1. Press driven gear and bearing assembly from propeller shaft with Universal Puller Plate Tool (C-91-37241). (Figure 1)

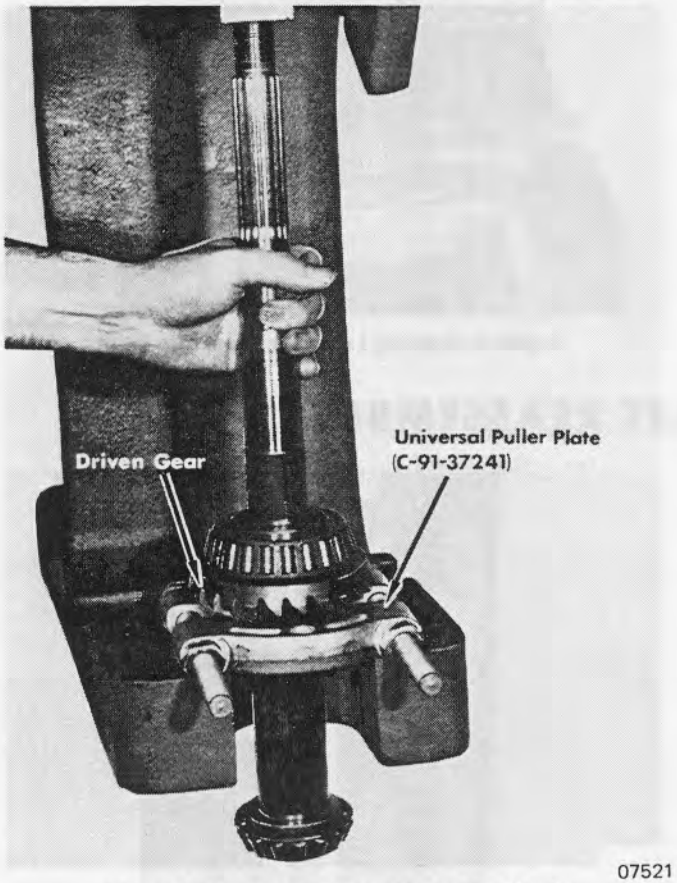

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Figure 1. Removing Driven Gear from Shaft

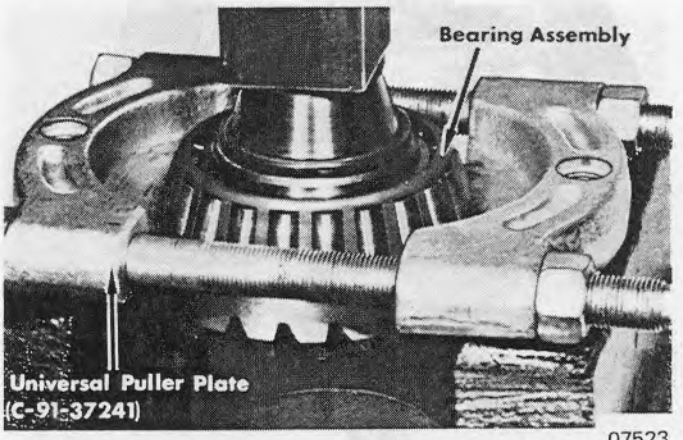

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Figure 2. Removing Bearing from Driven Gear

2. Using Universal Puller Plate Tool and suitable mandrel, press driven gear bearing from driven gear. (Figure 2)

   NOTE: Scrap bearing after pressing from driven gear.
3. Press front bearing from propeller shaft with Universal Puller Plate and suitable mandrel. (Figure 3)

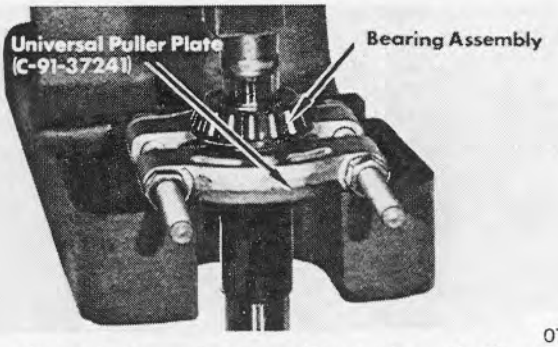

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Figure 3. Removing Front Bearing from Shaft

PROPELLER SHAFT REASSEMBLY - RIGHT HAND ROTATION

NOTE: For left hand rotation propeller shaft differences, refer to "Left Hand Rotation Variations", following.

1. Use a suitable mandrel and press driven gear bearing onto driven gear.
2. Align driven gear splines with propeller shaft splines and press gear on propeller shaft.
3. Press front propeller shaft bearing onto propeller shaft with suitable mandrel.

LOWER DRIVE SHAFT DISASSEMBLY

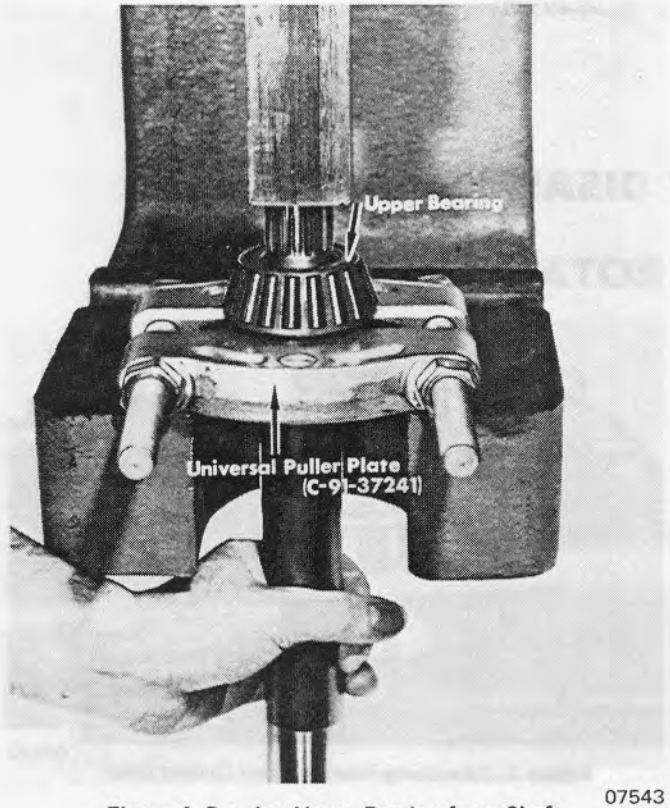

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Figure 4. Pressing Upper Bearing from Shaft

1. Press upper bearing from lower drive shaft with Universal Puller Plate Tool (C-91-37241). (Figure 4)
2. Use Universal Puller Plate to press lower bearing from lower drive shaft. (Figure 5)

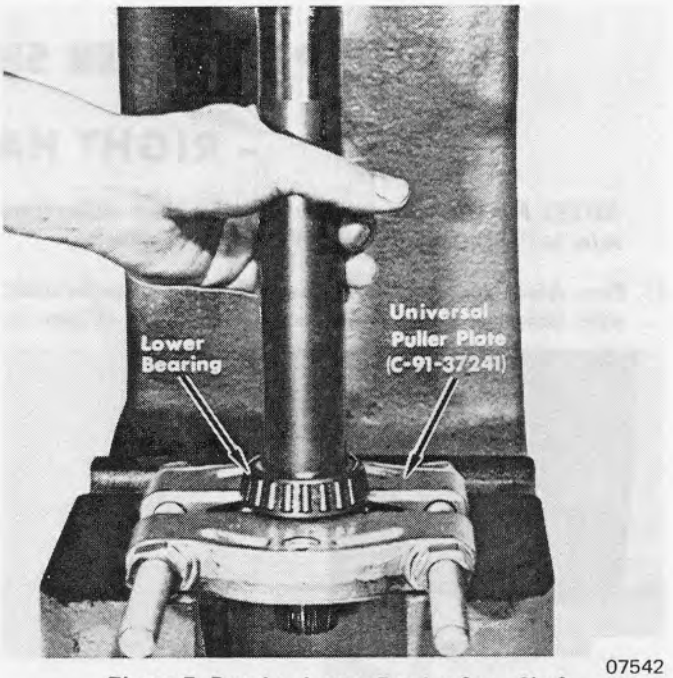

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Figure 5. Pressing Lower Bearing from Shaft

LOWER DRIVE SHAFT REASSEMBLY

Press lower bearing and upper bearing onto lower drive shaft with a suitable mandrel. (Figure 6)

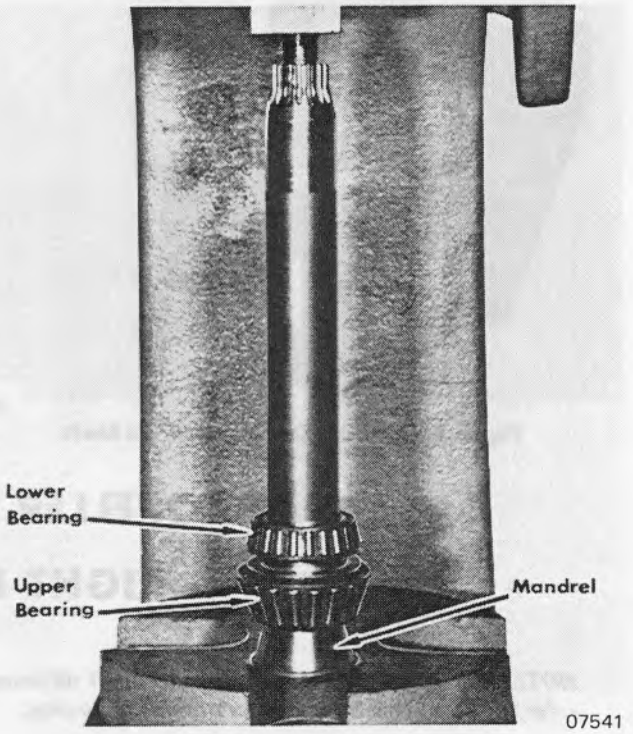

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Figure 6. Pressing Upper Bearing on Shaft

LEFT HAND ROTATION VARIATIONS

1. Left hand propeller shaft, front bearing and driven gear bearing have part numbers different than right hand rotation parts. These parts are assembled differently, as shown in Figure 7.

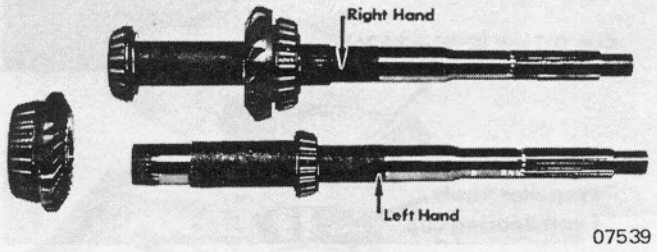


Figure 7. R.H. and L.H. Propeller Shaft Assemblies

2. Driven gear on left hand rotation is not a press fit to propeller shaft and is installed into gear housing before pinion gear is installed. Propeller shaft then is set into driven gear.

3. Gear and preload shimming are adjusted at same locations, but opposite results will occur when adding or removing shims to adjust gear lash as illustrated in "Gear Housing Reassembly", following. All other repair procedures are the same.

CAUTION: Propeller must be matched to rotation of drive unit.

GEAR HOUSING REASSEMBLY - RIGHT HAND ROTATION

NOTE: For left hand rotation, follow right hand rotation instructions, following, and refer to "Left Hand Rotation Variations", preceding.

IMPORTANT: Install same amount of shims that were removed. Follow "General Service Recommendations", preceding.

1. Use Drive Shaft Pinion Bearing Driver Tool (C-91-63638) and Installing Tool (part of C-91-31229A4) to install lower drive shaft pinion bearing. (Figure 1)

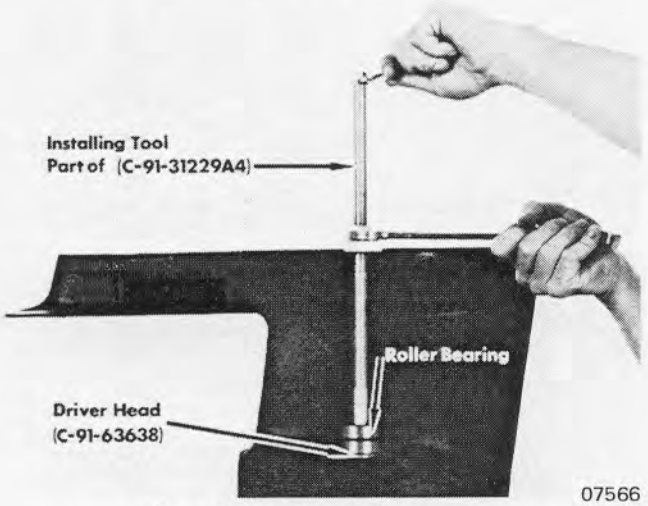


Figure 1. Installing Roller Bearing

2. Install shims and use Tool C-91-63619 to install small lower drive shaft bearing cup. (Figure 2)

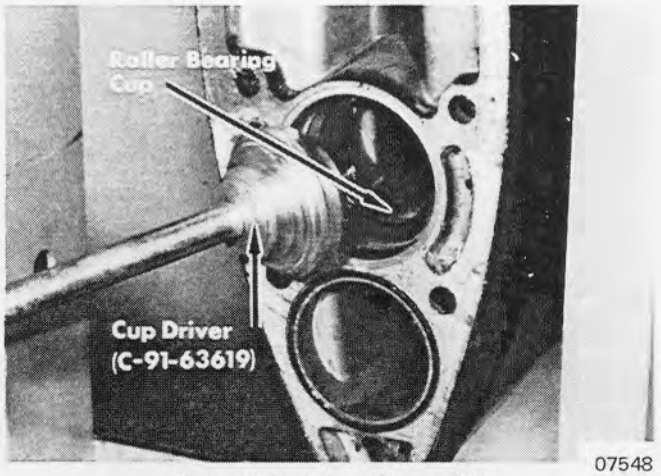


Figure 2. Installing Bearing Cup

3. Install shims and use Driver C-91-63626 to install front propeller shaft bearing cup. (Figure 3)

Figure 3. Installing Propeller Shaft Bearing Cup

NOTE: On left hand rotation gear housing, install driven gear before pinion gear and drive shaft.

4. Install drive shaft and bearing assembly into gear housing.
5. Install pinion gear, dished washer (concave side toward pinion gear) and pinion nut. Use Loctite Type "A" (C-92-32609-1) on pinion nut threads, if shimming is correct. Torque to specifications with Drive Shaft Socket (C-91-63620A1).
6. Carefully place Shimming Tool (C-91-63622) in gear housing. (Figure 4) Push in on drive shaft to simulate bearing preload and rotate slightly to seat bearing rollers. Hold drive shaft in this position and measure clearance between tool and gear with a feeler gauge. Clearance must be .025.

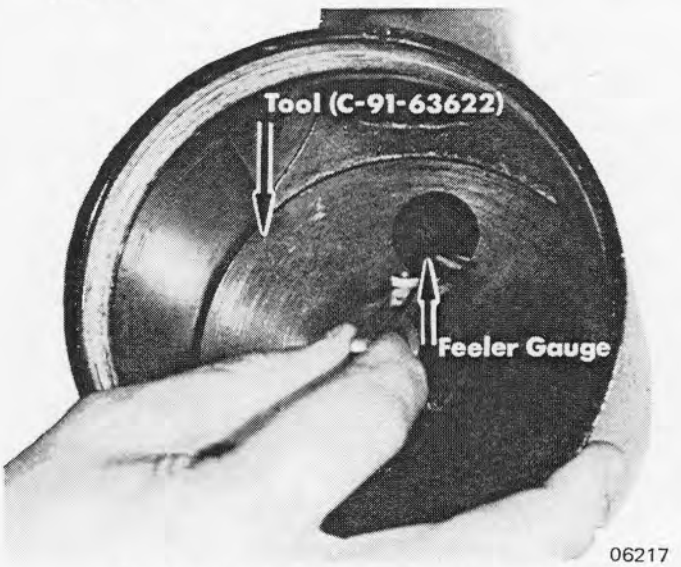


Figure 4. Checking Pinion Gear Shimming

7. If clearance is more or less than .025, remove drive shaft, pinion gear and drive shaft small bearing cup. Add or remove shims under bearing cup equal to the difference between .025 and your reading. Reinstall bearing cup, drive shaft and pinion gear. Use Loctite Type "A" (C-92-32609-1) on threads of nut. Recheck clearance.
8. Install assembled propeller shaft into gear housing. Tilt shaft slightly to allow front bearing to clear pinion gear.
9. Install propeller shaft preload shims, thrust ring and "O" ring into gear housing.
10. Install bearing carrier assembly and carrier locating key into gear housing.

NOTE: Pinion gear may need to be turned to align gear teeth.

11. Install tab washer and threaded retainer. While torquing threaded retainer to specifications, turn propeller shaft periodically to ensure that an over-preload does not exist on propeller shaft bearings. If propeller shaft cannot be turned by hand, add shims under bearing carrier thrust ring.
12. Use inch-pound torque wrench to check propeller shaft bearing preload torque. (Figure 5) Adjust to specifications, if necessary. To decrease torque, add shims under bearing carrier thrust ring. To increase torque, remove shims from under bearing carrier thrust ring.

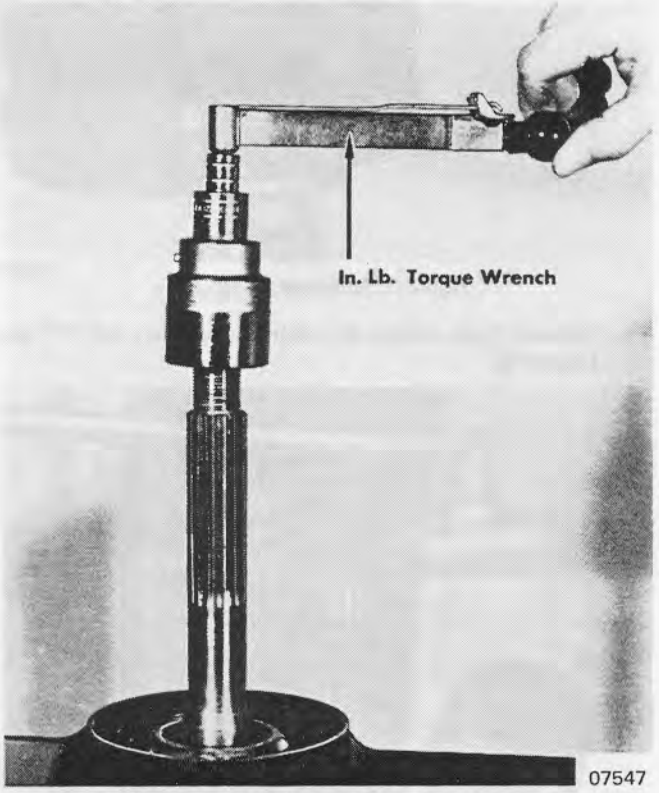


Figure 5. Checking Propeller Shaft Bearing Preload Torque

NOTE: Make a note of propeller shaft bearing preload torque for future use in determining lower drive shaft bearing preload torque and drive unit over-all bearing preload torque.

13. Use Dial Indicator and Indicator Rod (C-91-53459), position mark II, to check gear backlash which should be .011 to .015. (Figure 6) Push in on drive shaft to simulate bearing preload and turn drive shaft and pinion gear back-and-forth. Use light turning pressure to prevent propeller shaft from turning. Dial indicator registers amount of gear backlash (clearance) between gear teeth.

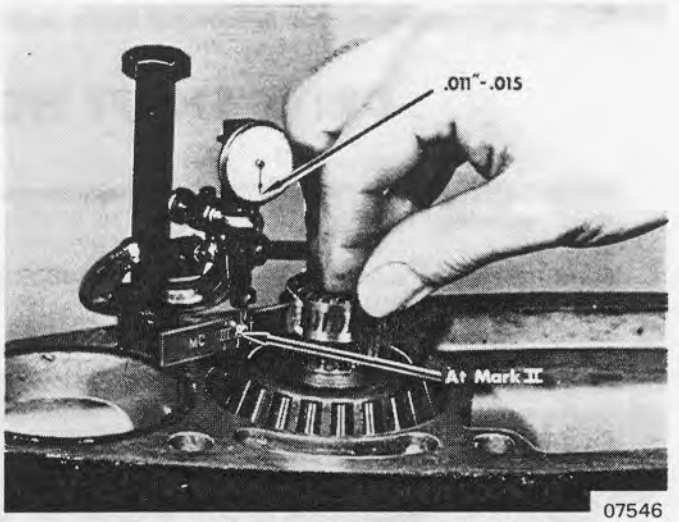


Figure 6. Checking Pinion Gear Backlash

14. Right Hand Rotation: If backlash is more than specified, remove shims from under propeller shaft front bearing cup. Remove same amount of shims from under bearing carrier thrust ring to keep bearing preload from changing. If backlash is less than specified, add shims under propeller shaft front bearing cup. Also add same mount of shims under bearing carrier thrust ring to keep bearing preload from changing.

    Left Hand Rotation: If backlash is more than specified, add shims under propeller shaft front bearing cup. Add same amount of shims under bearing carrier thrust ring to keep bearing preload from changing. If backlash is less than specified, remove shims from under propeller shaft front bearing cup. Also remove same amount of shims from under bearing carrier thrust ring to keep bearing preload from changing.
15. After bearing preload and gear backlash are adjusted, bend one tab on gear housing cover tab washer into slot provided on cover.

NOTE: Adjust lower drive shaft bearing preload torque as illustrated in "Gear Housing Installation", preceding.

DRIVE SHAFT HOUSING REMOVAL

1. Remove drive unit from transom as illustrated in "MerCruiser II-TR, Removing Stern Drive Unit", Section 2.
2. Separate gear housing from drive shaft housing as outlined in "Gear Housing Removal", preceding.

DRIVE SHAFT HOUSING INSTALLATION

1. Install gear housing as outlined in "Gear Housing Installation", preceding.

   NOTE: Engine alignment must be checked before installing drive unit. Refer to "225-255 II-TR Engine Alignment", Section 2.

2. Install drive unit as outlined in "225-255 II-TR, Stern Drive Installation", Section 2.

DRIVE SHAFT HOUSING DISASSEMBLY

IMPORTANT: Follow "General Service Recommendations", preceding.

1. Mount drive shaft housing in Repair Stand (C-91-33750) with Adaptor (C-91-60524A1).
2. Loosen bearing cup from housing as shown in Figure 1.

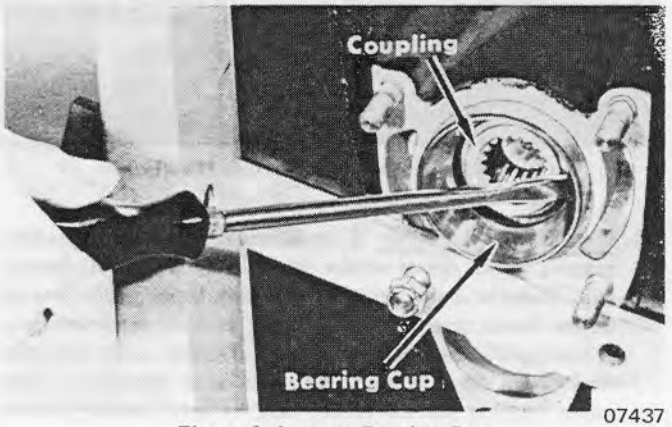


Figure 1. Loosen Bearing Cup

3. Remove bearing cup, shims, spacer and drive shaft coupling from housing. (Figure 2)

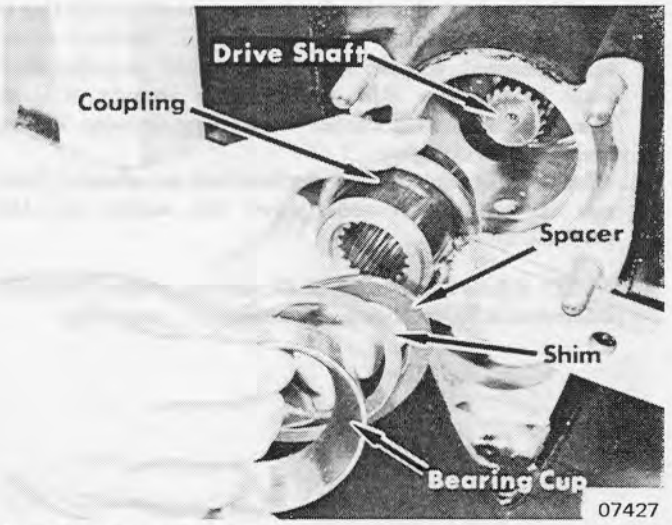


Figure 2. Removing Bearing Cup, Shims, Spacer and Coupling

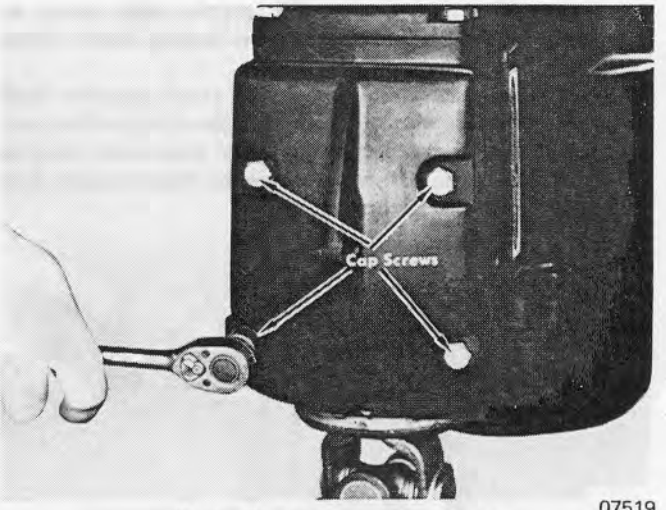


Figure 3. Removing Top Cover

4. Remove 4 cap screws and remove top cover and "O" ring. (Figure 3)

Figure 4. Loosening Universal Joint Nut

5. Remove 4 cap screws and remove back cover and "O" ring. Remove guide spring from universal joint shaft.
6. Install Bearing Holder Tool (C-91-63625) in place of rear cover. (DO NOT over-tighten cap screws.) Loosen universal joint shaft nut as shown in Figure 4. Remove nut and universal joint assembly. (Figure 5)

NOTE: Disassembly and reassembly of universal joint follows.

Figure 5. Removing Universal Joint Shaft

7. Remove washer, shims and tab washer. (Figure 6)

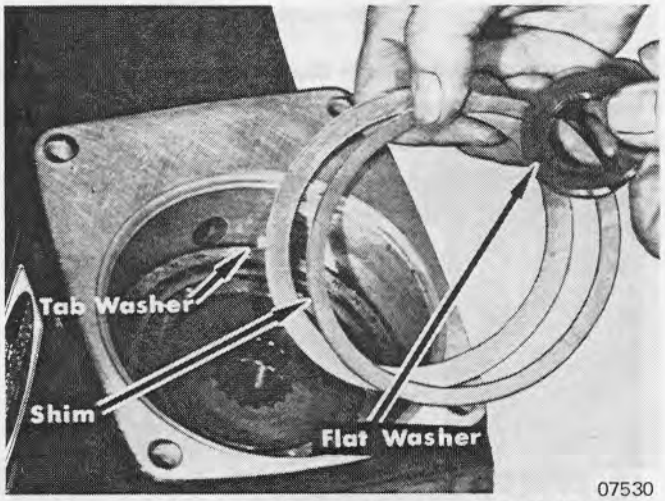


Figure 6. Removing Washer, Shims and Tab Washer

8. Remove drive gear and bearing assembly and remove spacer and front bearing. (Figure 7)

   NOTE: Refer to drive gear bearing removal and installation, following.

9. Using Slide Hammer Tool (C-91-34569A1), remove universal joint front bearing cup. (Figure 8) Remove shims.
10. Remove universal joint shaft oil seal with Slide Hammer Tool. (Figure 9) Remove "O" ring from drive shaft housing pilot.
11. Bend tab washer down from upper drive shaft bearing nut. (Figure 10)

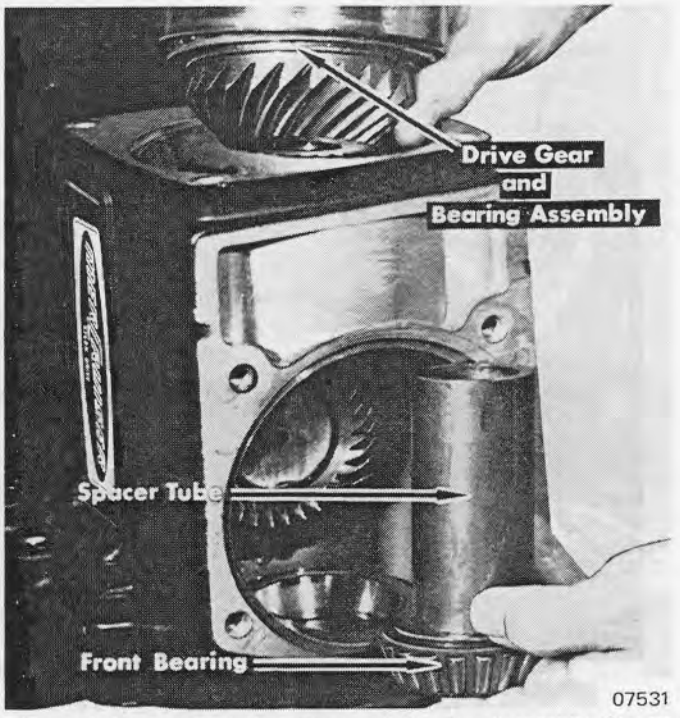


Figure 7. Removing Drive Gear and Bearing Assembly, Spacer and Front Bearing

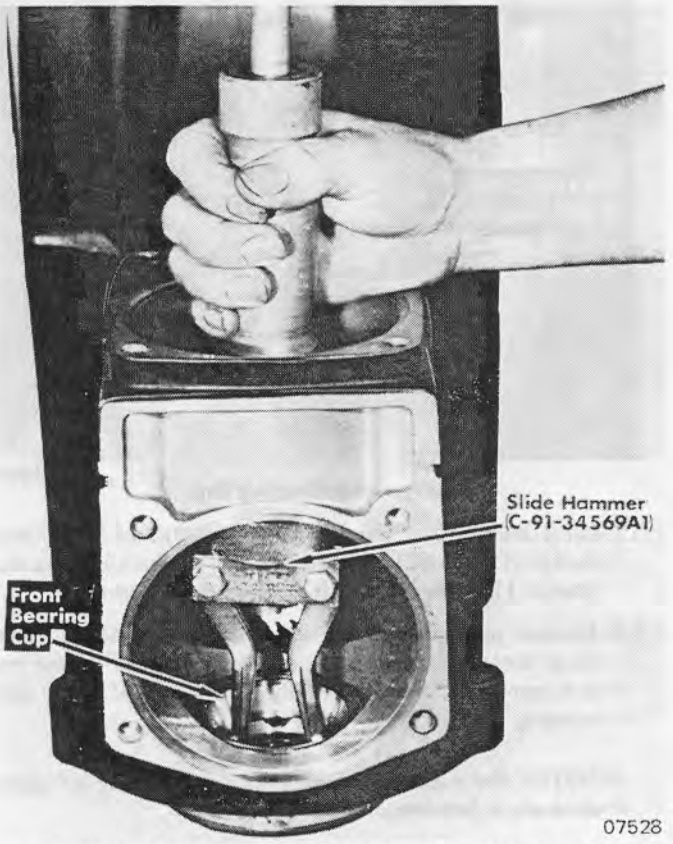


Figure 8. Removing Universal Joint Front Bearing Cup

Figure 9. Removing Universal Joint Shaft Oil Seal

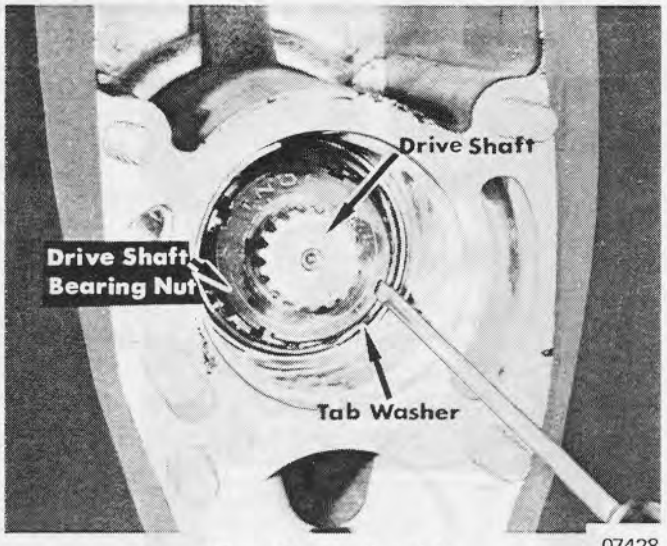


Figure 10. Bending Tab

12. Using Bearing Nut Wrench (C-91-63620) and Drive Shaft Socket (C-91-63621), loosen upper drive shaft bearing nut. (Figure 11) Turn drive shaft clockwise to loosen nut.

13. Remove nut, tab washer, flat tabbed washer and bearing from bottom of drive shaft housing. Remove driven gear and upper drive shaft assembly from top of drive shaft housing. (Figure 12)

NOTE: Refer to disassembly and reassembly of upper drive shaft, following.

14. Remove driven gear bearing cup and shims with Slide Hammer Tool (C-91-34569A1). (Figure 13)

Figure 11. Loosening Bearing Nut

15. Using Slide Hammer, remove bottom bearing cup. Refer to Figure 13, as procedure is similar.
16. Remove 3 screws, check valve cover, check valve, spring and gasket.
17. Remove quad (sealing) ring from check valve plunger.

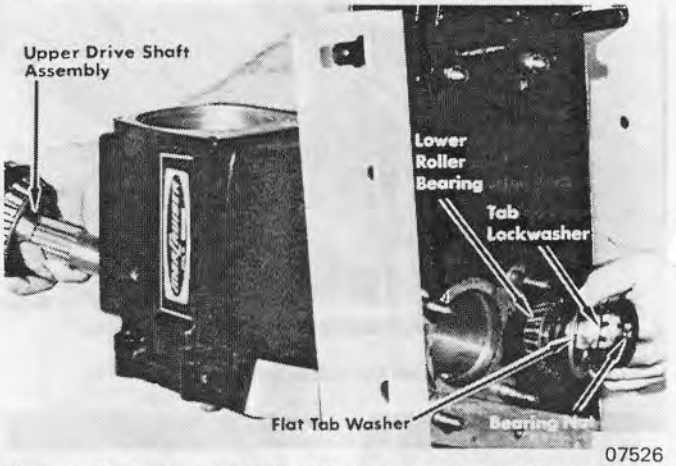


Figure 12. Removing Drive Shaft Assembly and Components

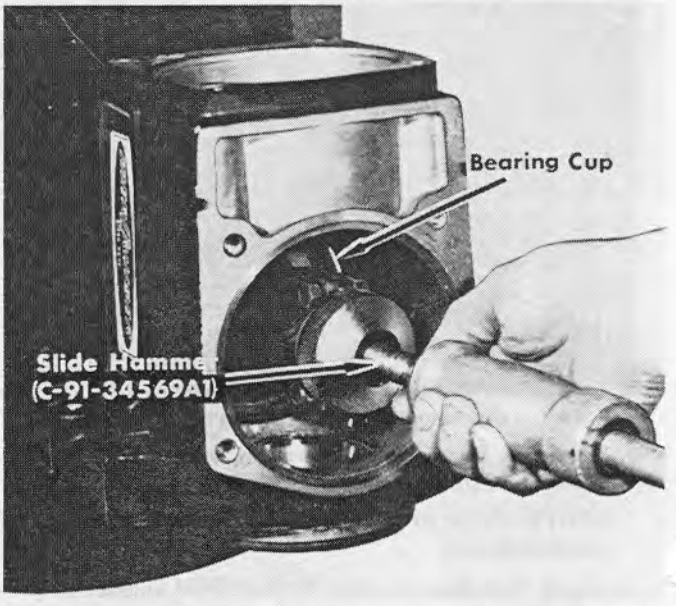


Figure 13. Removing Driven Gear Bearing Cup

UNIVERSAL JOINT DISASSEMBLY

1. Using a punch and hammer, drive off universal joint bearing snap rings. (Figure 1)

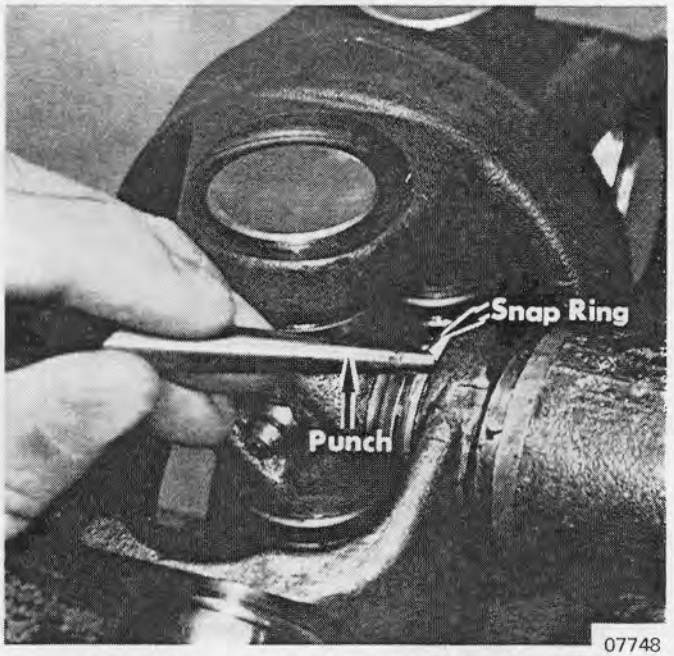
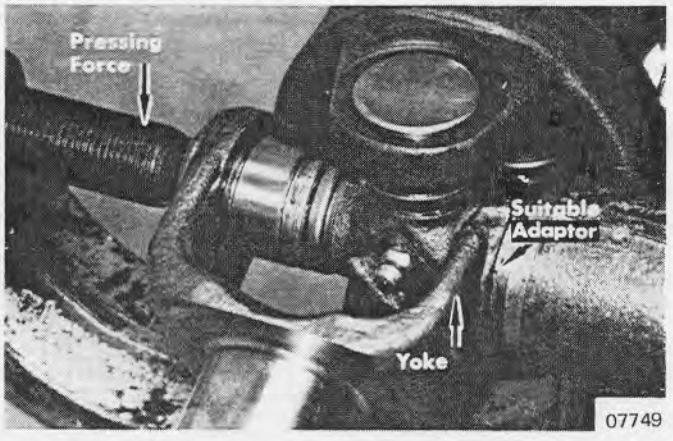


Figure 1. Removing Universal Joint Bearing Snap Rings



2. With suitable adaptor to support universal joint yoke, press on one bearing until opposite bearing is pressed into adaptor. Remove loose bearing. (Figure 2)
3. Turn universal joint assembly 180° and press on bearing cross member to remove second bearing. (Figure 3) Remove all bearings in this manner.

Figure 3. Removing Second Universal Joint Bearing

Figure 2. Removing First Universal Joint Bearing

UNIVERSAL JOINT REASSEMBLY

1. Place universal joint bearing caps in yoke and start them on bearing cross members. Finish installation by pressing bearings through yoke and onto crossmembers. (Figure 4)
2. Install bearing cap retaining snap rings. (Figure 5)

Figure 4. Installing Universal Joint Bearings

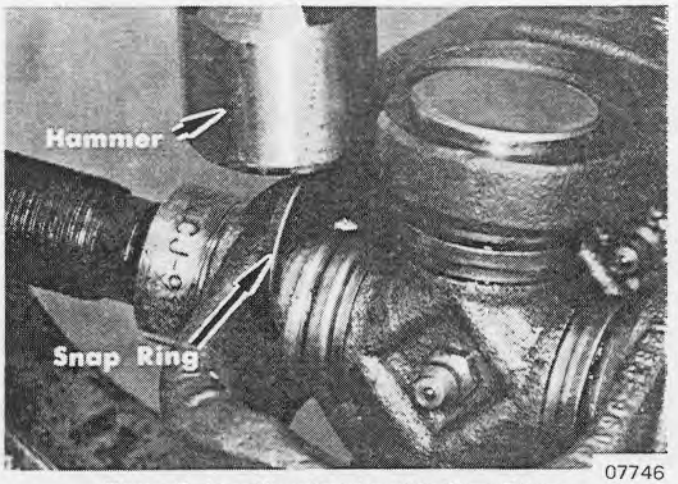


Figure 5. Installing Bearing Cap Snap Rings

UPPER DRIVE SHAFT and GEARS DISASSEMBLY

1. Press upper drive shaft from driven gear and bearing assembly. (Figure 1)

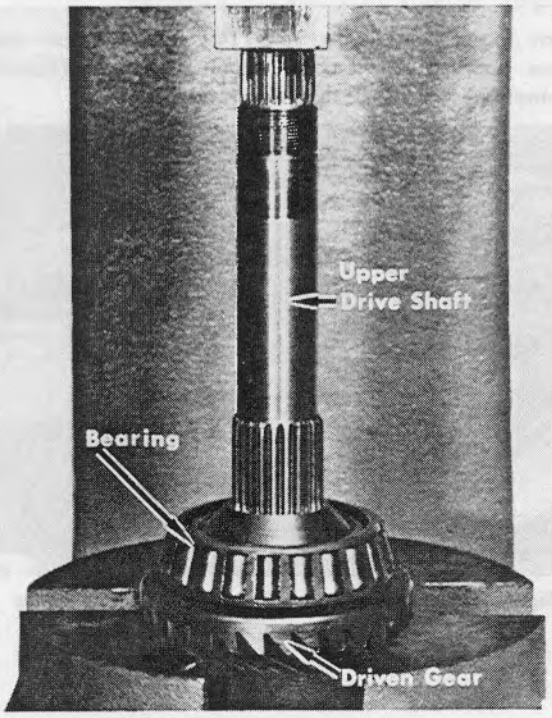


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Figure 1. Pressing Shaft from Gear

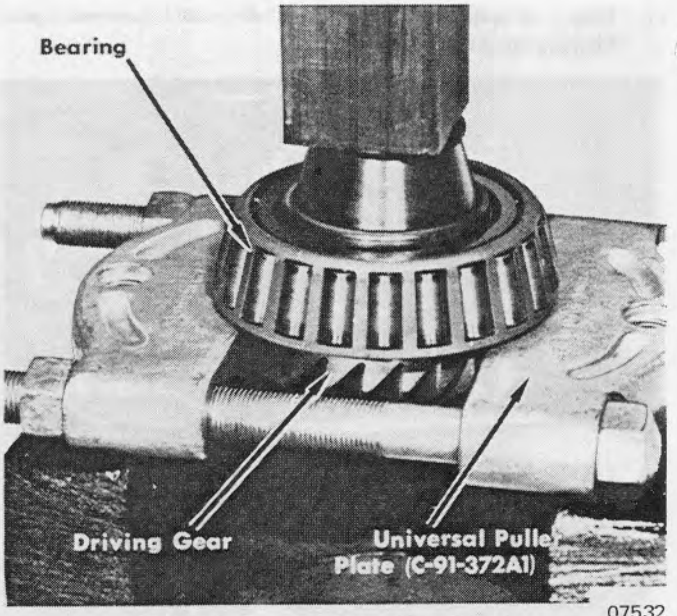

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Figure 2. Pressing Gears from Bearings

2. Using Universal Puller Plate Tool (C-91-37241) and suitable mandrel, press drive gear and driven gear from bearings. (Figure 2)

NOTE: Remove bearings only if replacement is necessary. Bearings are damaged beyond repair during removal.

UPPER DRIVE SHAFT and GEARS REASSEMBLY

1. Press bearings onto drive and driven gears with suitable mandrel.

2. Press upper drive shaft into driven gear and bearing assembly.

DRIVE SHAFT HOUSING REASSEMBLY

IMPORTANT: Follow "General Service Recommendations", preceding. Install same amount of shims that were removed.

1. Install driven gear bearing shims. Use Bearing Cup Driver Tool (C-91-63626) and install driven gear bearing cup. (Figure 1)

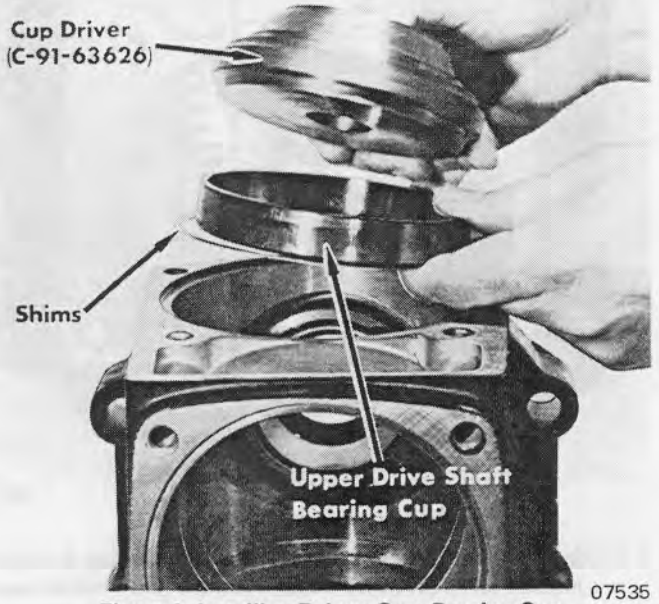


Figure 1. Installing Driven Gear Bearing Cup

2. Install upper drive shaft bearing cup, as in Step 1 above, with cup driver.
3. Install assembled upper drive shaft into top of housing. Install drive shaft roller bearing, flat tabbed washer, tab washer (align tabs on inside diameter of both washers with slot in drive shaft) and bearing nut (chamfered side of nut toward bearing) into bottom of drive shaft housing. (Figure 2)

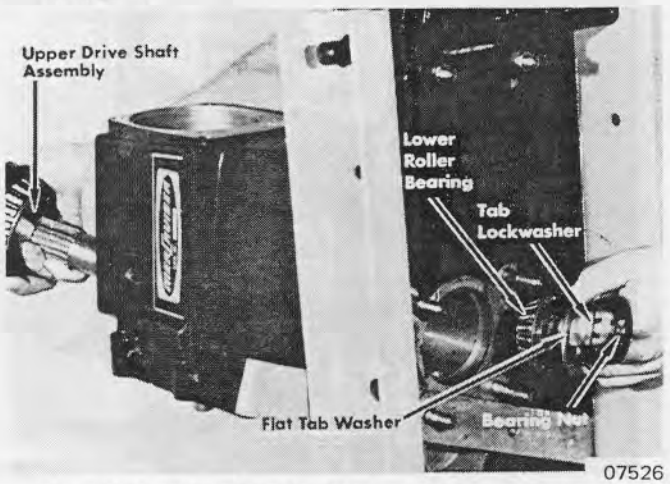


Figure 2. Installing Drive Shaft Assembly and Components

4. Using Drive Shaft Socket and Wrench (C-91-63620A1), turn drive shaft counterclockwise and tighten nut (Figure 3) to obtain 15 to 20 in. lbs. (2.66 to 3.55kg/cm) of preload torque on upper drive shaft bearings. Check

Figure 3. Tightening Bearing Nut

preload as illustrated in Figure 4.

NOTE: Make a note of bearing preload torque for future use in determining universal joint shaft bearing preload torque.

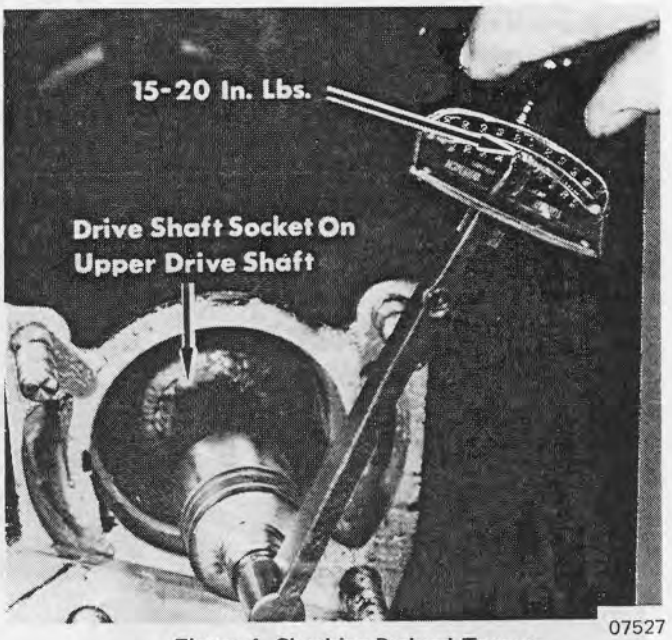


Figure 4. Checking Preload Torque

5. Insert Shimming Tool (C-91-63623) into drive shaft housing with hole marked "MCIITR" toward driven gear. gear.

CAUTION: Tool may be damaged if installed improperly.

6. Use feeler gauge to measure gap (.025) between driven gear and shimming tool. (Figure 5) If feeler gauge reading is too low, remove shims from under driven gear bearing cup. If reading is too high, add shims under bearing cup.

NOTE: If driven gear bearing cup shims are increased or decreased, upper drive shaft bearings preload torque must be readjusted (as in Steps 1 thru 4, preceding).

Figure 5. Checking Driven Gear Shimming

7. Align slot on upper drive shaft bearing nut with tab on tab washer and bend tab into slot.
8. Install universal joint shaft seal in housing with Installation Tool (C-91-63619). (Figure 6) Use side one of tool the first time that seal is replaced and side two the second time seal is replaced.

   NOTE: Seal is factory-installed to be flush with housing. Side one of tool will install seal 1/16" (1.6mm) into housing cavity - side two 1/8" (3.2mm) into housing cavity. If universal joint shaft has been replaced, oil seal again should be installed flush with housing.

Figure 6. Installing Universal Joint Shaft Oil Seal

Figure 7. Installing Bearing Cup

9. Install shims into drive shaft housing and, using flat side of Installation Tool (C-91-63619) toward gear, install universal joint shaft tapered roller bearing cup. (Figure 7)

Figure 8. Installing Bearing, Spacer and Gear and Bearing Assembly

10. Install bearing, spacer and drive gear and bearing assembly in housing. (Figure 8)
11. Install flat washer, with tab in oil hole, and install shims and universal joint shaft washer. (Figure 9)

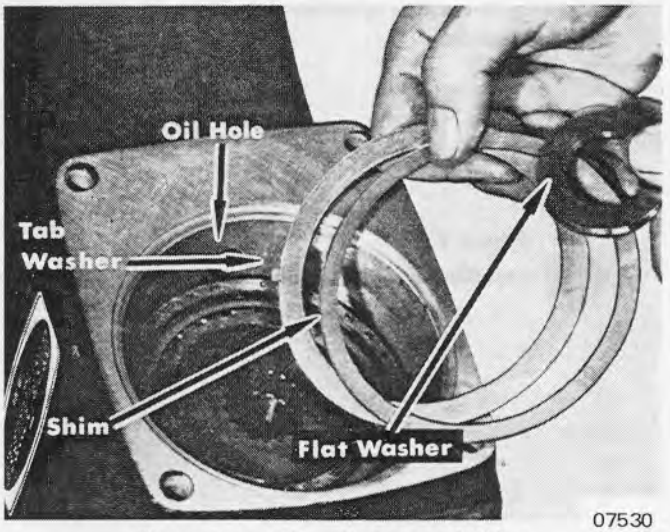


Figure 9. Installing Washers and Shims

12. Install universal joint shaft through front bearing, spacer and drive gear. Install nut on shaft. (Figure 10)

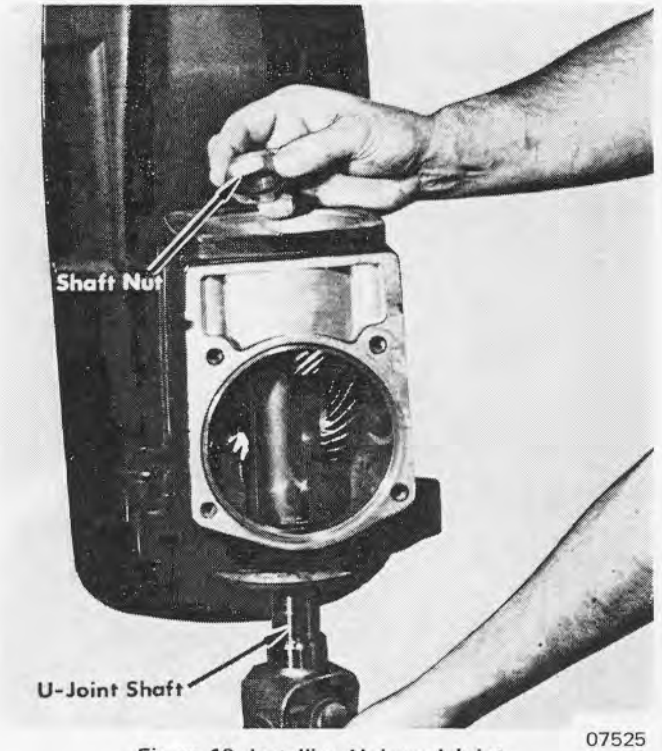


Figure 10. Installing Universal Joint

13. Install Bearing Holder Tool (C-91-63625) and torque universal joint shaft nut to specifications. (Figure 11)
14. Install rear cover "O" ring onto rear cover, then rear cover with 4 cap screws. Torque screws to specifications.
15. Check drive shaft housing over-all bearing preload torque at upper drive shaft. (Figure 4) Preload should be 5 to 11 in. lbs. (.887 to 1.95kg/cm) above preload, measured in drive shaft housing reassembly, Step 4. Add shims under rear cover to increase preload and remove shims to decrease preload.

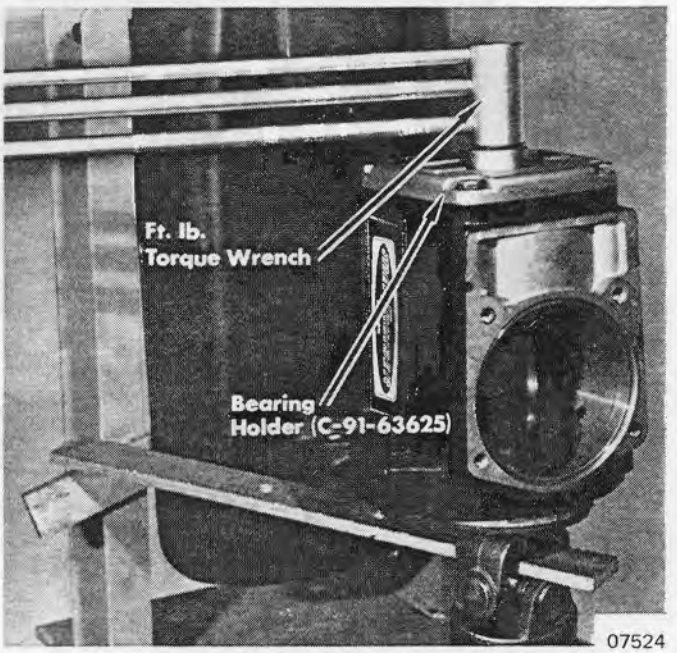


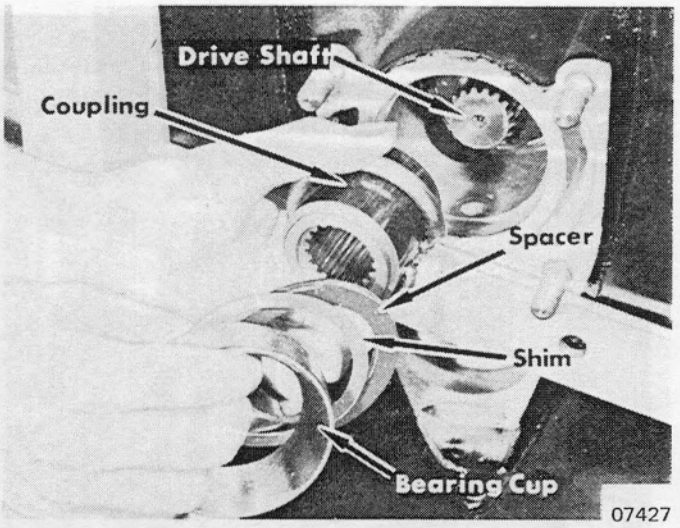
Figure 11. Torque Universal Joint Shaft Nut

16. Install Shimming Tool (C-91-63624) into drive shaft housing. Use feeler gauge to measure gap (.025) between drive gear and shimming tool. (Figure 12) If feeler gauge reading is too low, add shims under universal joint shaft front bearing cup and remove same amount of shims from under rear cover. If reading is too high, remove shims from under front bearing cup and add shims in same amount under rear cover.

Figure 12. Measuring Drive Gear Shimming

NOTE: If gear housing, drive shaft housing, lower drive shaft or lower drive shaft components have been replaced, lower drive shaft bearing preload must be adjusted. Overshim bearing cup .060 or more and refer to "Gear Housing Installation", preceding.

17. Install "O" ring on top cover. Install top cover with 4 cap screws to specifications.
18. Install drive shaft coupler, spacer, shims and bearing cup. (Figure 13) Seat bearing cup in drive shft housing with mallet.



19. Install quad (sealing) ring on check valve plunger and install spring, check valve, gasket and cover with 3 screws. Torque to specifications.
20. Install new "O" ring on drive shaft housing pilot with Bellows Adhesive (C-92-36340).
21. Install gear housing as outlined in "Gear Housing Installation", preceding.

Figure 13.
Installing Bearing Cup, Shims, Spacer and Coupling

GIMBAL HOUSING DISASSEMBLY

1. Remove gimbal housing and transom plate from boat by referring to - "Removal, Installation and Alignment", Section 2.

   NOTE: Remove oil hose at bell housing to drain gear lubricant from reservoir or, when changing bellows or bell housing, plug oil hose to retain gear lubricant in reservoir.

2. Remove trim limit switch and trim position sender assemblies from gimbal ring.

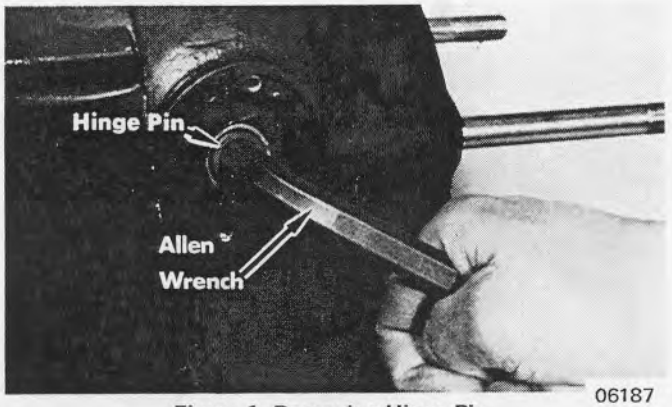


Figure 1. Removing Hinge Pin

3. Remove hinge pins with 9/16 allen wrench. (Figure 1) Loosen bellows clamp to remove bellows. (Figure 2)
4. Remove oil hoses and oil check valve (explained previously), if necessary.

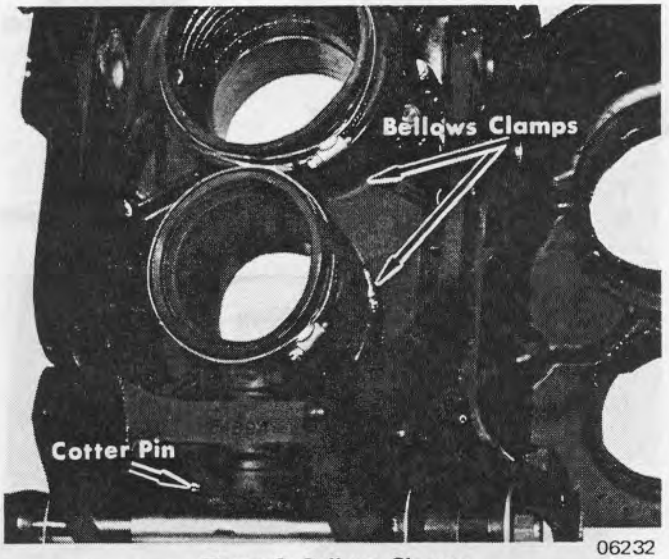


Figure 2. Bellows Clamps

5. Remove cotter pin, to allow removal of lower swivel pin, and remove swivel pin.
6. Remove allen head screws that hold upper swivel pin in position on gimbal ring. (Figures 3 and 5) Loosen steering arm elastic stop nut and screw from swivel pin. (Figure 4) Large nut cannot be removed from swivel pin until swivel pin is removed.

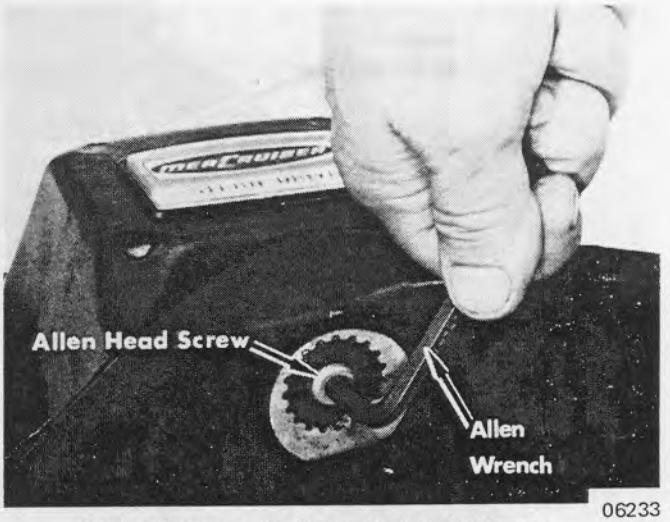


Figure 3. Removing Upper Swivel Pin Screw

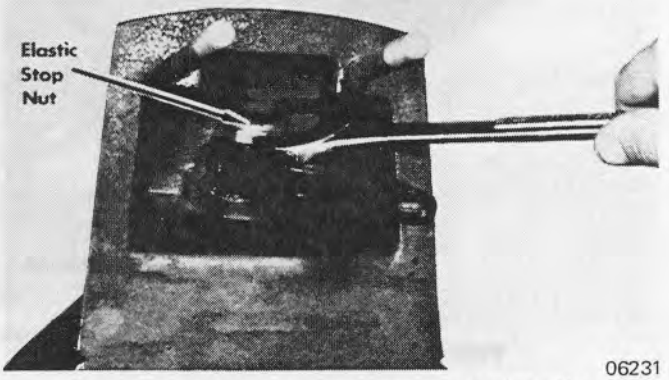


Figure 4. Removing Steering Arm Elastic Stop Nut

7. Remove upper swivel pin with Slide Hammer Puller (C-91-34569A1) and Puller (C-91-38919) thru lower swivel pin hole. (Figure 6) Gimbal ring now is loose from housing.

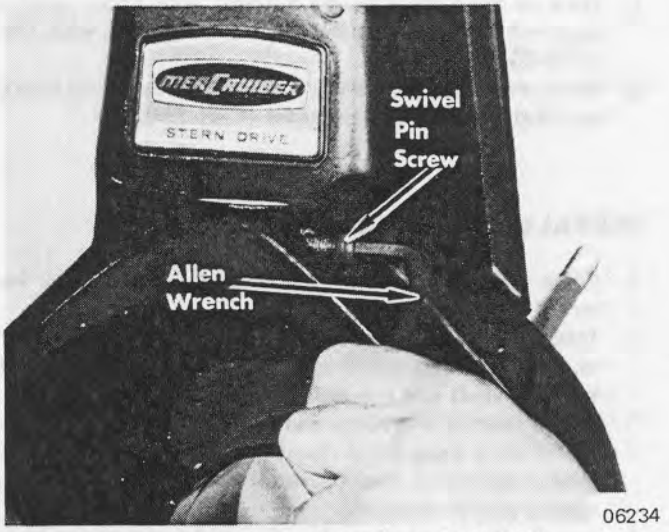


Figure 5. Removing Screw from Swivel Pin

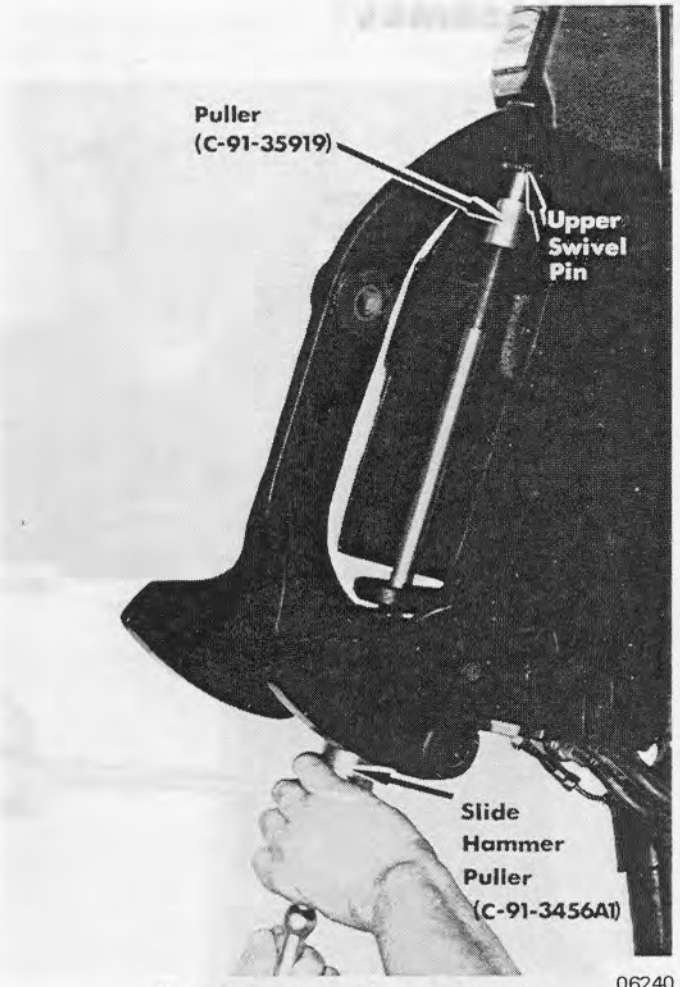


Figure 6. Removing Upper Swivel Pin

8. Remove grease fitting from top of gimbal housing (Figure 7) and remove upper needle bearings and seals with long thin drift, if necessary. NOTE that they will be damaged in removal.
9. Remove needle bearing and oil seals from gimbal ring with any 1¼" O.D. mandrel.
10. Remove anodic plate.
11. Remove hydraulic adaptor lines and hoses as required.
12. Remove phillips head screws to remove oil reservoir cover.
13. Be sure to inspect exhaust tube "O" ring and bell housing gasket and replace if necessary.

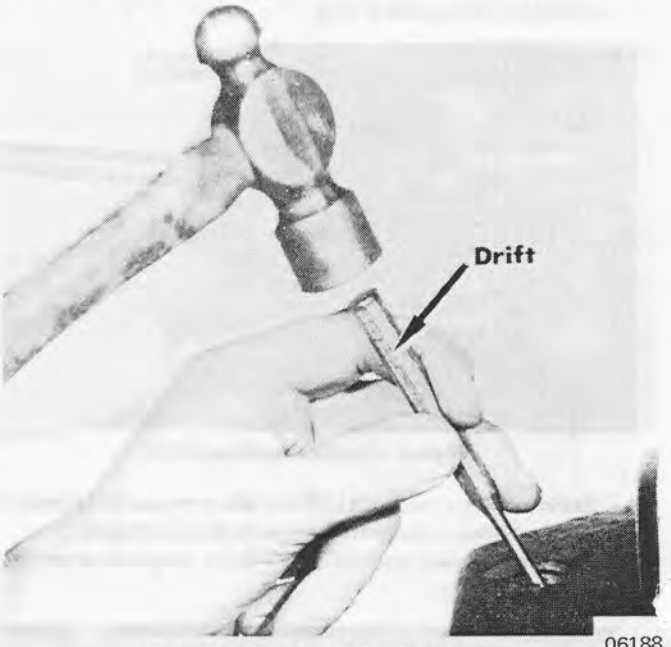


Figure 7. Removing Needle Bearings

GIMBAL HOUSING REASSEMBLY

INSTALLING NEEDLE BEARINGS and OIL SEALS

1. Press or drive upper needle bearings with upper small and large oil seals (lips up) into gimbal housing with Driver (C-91-55924).
2. Press or drive lower needle bearing and lower oil seals (lip up) into gimbal ring with Driver (C-91-55924).

INSTALLING GIMBAL RING

1. Align gimbal ring with gimbal housing and install lower swivel pin and cotter pin.
2. Install upper swivel shaft thru washers between gimbal ring and housing and under steering arm, placing elastic stop nut over shaft as it is installed.
3. Install steering arm screw and nut, but do not tighten.
4. Install allen head screw (located at upper starboard side of gimbal ring) with Anti-Corrosion Grease (C-92-45134) and torque to specifications.
5. Install allen head pipe plug (located in bottom of swivel shaft) with Anti-Corrosion Grease.
6. Tighten elastic stop nut on swivel pin, pulling up on gimbal ring to obtain .005 to .007 clearance between washer and gimbal ring. (Figure 8)
7. Torque steering arm screw and nut to specifications.
8. Install grease fitting which is located on top of gimbal housing.

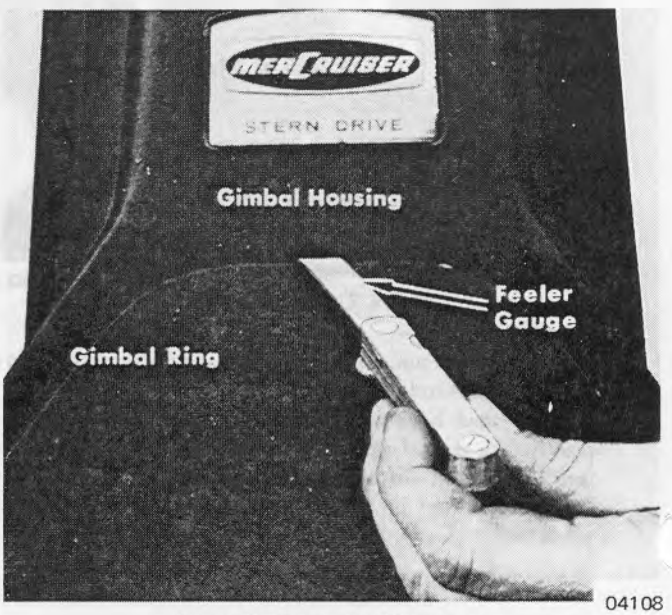


Figure 8. Measuring Clearance

BELL HOUSING INSTALLATION

1. Before installing universal joint bellows, clean outside diameter of gimbal housing and bell housing bellows mounting flanges first with a wire brush or sandpaper, then with lacquer thinner. Clean inside diameter of bellows with lacquer thinner. Apply Bellows Adhesive (C-92-36340A1) to inside diameter of each end of bellows.

WARNING: Bellows Adhesive contains TOLUOL. Avoid constant contact with skin or continued breathing of vapor. Keep away from children. Flammable -- DO NOT USE NEAR FIRE OR FLAME. Allow adhesive to dry 5 to 10 minutes, or until no longer tacky, before installing bellows. In cold weather, heat bellows to room temperature with heat lamp or large electric light bulb to make more pliable for easier installation.

2. Install bellows with clamps and tighten clamps to specifications.
3. Install exhaust bellows in same manner, without bellows adhesive.
4. Reassemble oil check valve (preceding).
5. Place spacer washers over hinge pin bushings and position bell housing in gimbal ring.
6. Install hinge pins with Loctite "A" (C-92-32609) on screw threads and tighten to specifications.
7. Install oil hose between fittings on valve assembly and gimbal housing, tightening hose clamps to specifications.
8. Check universal joint bellows carefully for kinks or uneven folds.

TRIM SWITCH and TRIM SENDER INSTALLATION

1. Thread switch and sender leads into gimbal housing. Install switch lead retainer (Figure 2) and tighten screws to 12 ft. lbs. (1.66mkg). Observe position of leads so that they will not interfere with gimbal ring at full starboard turn. Sender leads must point downward 0° to 30°.
2. Align marks on housing and hex rotor shaft (Figure 1) before installing on gimbal ring.
3. Align shaft with hinge pin hex and push into position.
4. Follow trim limit or trim indicator adjustment, following.
5. Install and tighten adjusting screws.
6. Connect trim sender lead with purple sleeve to purple/white wire on engine harness.
7. Connect black trim sender lead to black lead in engine harness.

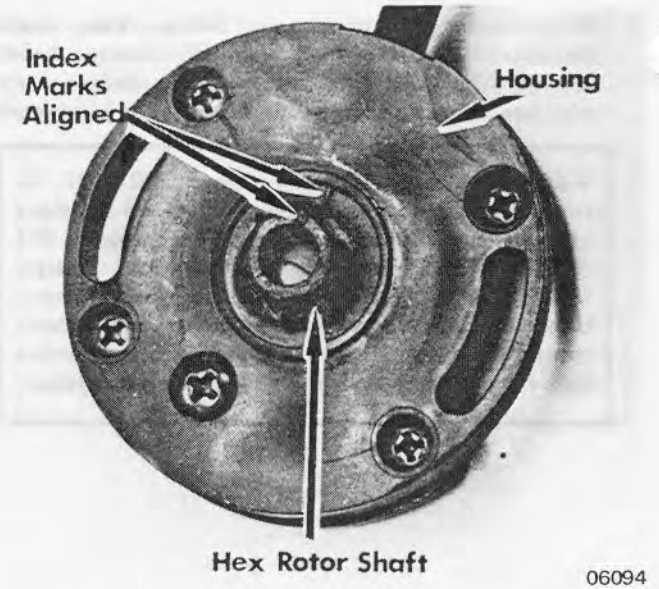


Figure 1. Alignment Marks

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TRIM LIMIT READJUSTMENT

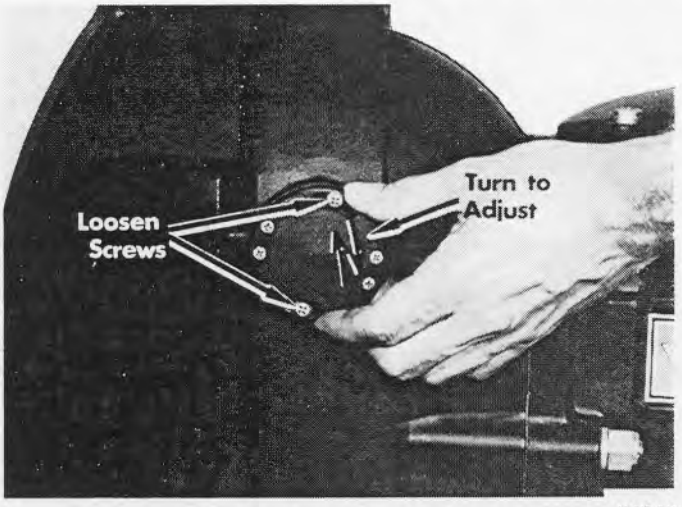

Figure 2. Adjusting Trim Limit Switch

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Limiting the 225 or 255 II-TR drive outward trim travel is necessary to ensure safe control at high speeds with certain boats. These boats become difficult to control when the drive is trimmed out too far. Readjustment of the trim limit switch, to restrict the drive's outward travel, will keep it within a safe trimming range.

1. Place drive at maximum desired outward travel (trim) position.
2. Turn stern drive hard to right (starboard).
3. Remove limit switch leads from harness and connect leads to continuity meter.
4. Loosen adjusting screws (Figure 2) which hold trim limit switch. It is normally in the closed circuit position.
5. Rotate switch housing in either direction until switch circuit just opens.
6. Tighten adjusting screws and reconnect switch leads to complete adjustment.

TRIM INDICATOR SENDER ADJUSTMENT

The following procedure is for fine adjustment of instrument needle to bottom of green arc on instrument face.

1. Turn stern drive hard to left (port) in the full "Down" trim position.
2. Loosen 2 adjusting screws (Figure 2) which hold Indicator Sender.
3. Turn ignition key to run position.
4. Rotate Indicator Sender housing in either direction (Figure 2) to show indicator instrument needle on bottom of green arc. (Figure 3)
5. Tighten adjusting screws, check instrument reading and turn ignition key to "off" position.

Figure 3. Trim Indicator Instrument

04591

SECTION 6 - DRIVE SYSTEMS

MERCRUISER

PART G - MERCRUISER II-TR TRANSMISSION

MERCURY MARINE

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MERCRUISER 225-255 II-TR TRANSMISSION MODEL A

DESCRIPTION

The direct drive transmission consists of a planetary gear set, forward multiple disc clutch, reverse band clutch, oil pump, pressure relief valve, rotary control valve and electric shift motor. All, except the shift motor, are contained in aluminum housing and provide forward, reverse and neutral operation.

PRECAUTIONS

1. Change oil once each season.
2. Check oil level at normal engine operating temperature immediately after engine has been shut off.
3. Use clean containers for handling transmission fluid.
4. Fill transmission before starting engine.
5. Use only automatic transmission fluid (ATF) Type "A" Suffix "A" or Dextron.
6. If transmission malfunctions, check transmission oil pressure and temperature. Normal pressures and temperatures are as follows:
   a. Oil temperature at normal engine operating temperature should not exceed 190° F (88° C).
   b. Oil pressure at 750 RPM is 80-105 PSI (5.62-7.38 kg/cm^2).
   c. After shifting, and pressure has stabilized, pressure must not fluctuate more than 5 PSI (.35 kg/cm^2) when shifting from forward to neutral to reverse.
   d. Oil pressure in forward gear at 4000 RPM is 120-145 PSI (8.44-10.19 kg/cm^2).
7. Except in emergency, never shift at engine speeds above 1500 RPM.
8. Do not permit propeller shaft to rotate for extended periods of time when transmission is inoperative. This propeller shaft rotation could be caused by towing or operation of a second engine that causes the propeller to "windmill". An inoperative stern drive should be tilted up to "trailer" position to prevent "windmilling".
9. Do not mix types or brands of automatic transmission fluid.
10. Never remove oil cooler hoses or use smaller-than-recommended 3/8" (9.5mm) inside diameter cooler hoses when operating transmission.
11. Check engine alignment each time engine is replaced.

TOOLS

Special tools, required for transmission repair, are contained in Tool Kit C-91-65307A1.

LUBRICATION RECOMMENDATIONS

Properties of oil used in the transmission are extremely important for proper function of the hydraulic system; therefore, it is necessary that recommended oil, automatic transmission fluid (ATF) Type "A" Suffix "A" or Dextron, be used.

PROCEDURE for FILLING TRANSMISSION with OIL

When filling transmission, add oil until level reaches full mark on dipstick. Unit should be shifted several times at engine idle speed to ensure that all oil circuits are filled.

CAUTION: Be sure that oil cooler hoses are installed and that transmission contains oil before cranking or starting engine.

PROCEDURE for CHECKING OIL

Transmission should be checked periodically to assure proper oil level. Check oil level immediately after stopping engine. If necessary, add sufficient oil to bring transmission oil level to "Full" mark on dipstick.

CHANGING OIL

NOTE: Transmission oil must be changed once each season.

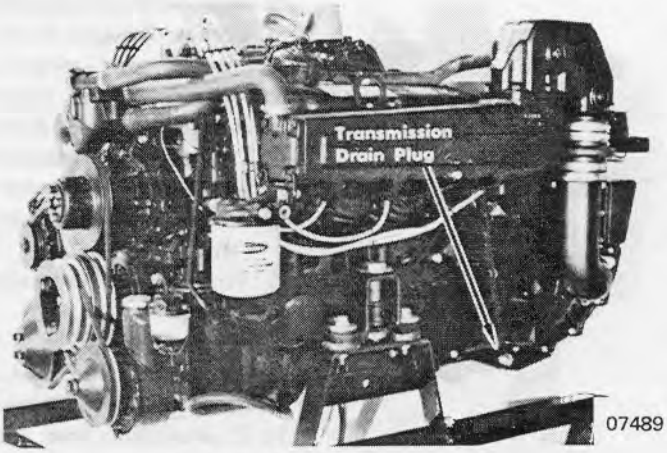

Figure 1. Draining Transmission

1. Place a suitable container under drain location. (Figure 1)
2. Remove drain plug. (Figure 1)
3. After transmission fluid has drained, reinstall drain plug.
4. Fill transmission to "Full" mark on dipstick (2 qts. capacity).
5. Run engine for 2 minutes at idle speed to fill all circuits.
6. Stop engine and check fluid level on dipstick. Add fluid as required to bring level up to "F" mark on dipstick.

KEY to TROUBLESHOOTING CHART on PAGE 6G-3

1. *Damaged "O" rings*
2. *Loose bolts - tighten*
3. *Damaged gasket*
4. *Damaged oil seal*
5. *Housing leaks, porosity - replace (main transmission housing, control valve housing, pump housing, output housing)*
6. *Dipstick tube leaks - replace*
7. *Damaged control valve "O" rings - replace*
8. *Foreign material on mating surfaces - clean*
9. *Damaged oil cooler, water and oil mixing - replace*
10. *No oil or oil level low - add oil and determine cause of oil loss*
11. *Sheared pump drive key - replace*
12. *Faulty oil gauge - clean or replace, bleed air from gauge line*
13. *Dirty oil screen - clean*
14. *Low oil level - add oil to proper level*
15. *Relief valve stuck - replace valve*
16. *Worn oil pump - replace if necessary*
17. *High oil level - drain oil to proper level*
18. *Dirty oil cooler or blocked line - clean*
19. *Worn or misaligned output sleeve in transmission housing - replace*
20. *Worn or damaged clutch piston oil seals*
21. *Worn or damaged teflon seal rings - replace*
22. *Forward clutch pack improperly assembled*
23. *Damaged or broken forward clutch return spring - replace*
24. *Worn or damaged clutch plates - replace clutch pack*
25. *Improperly assembled reverse clutch band*
26. *Worn or damaged reverse band - replace*
27. *Nicks on gears - remove with stone*
28. *Excessive runout between engine housing and crankshaft*
29. *Damaged flywheel drive plate assembly - replace*
30. *Control valve assembled incorrectly*
31. *Electric shift motor not working properly - replace*
32. *Electric wires from remote control not connected properly - check*
33. *Wrong oil used in transmission - change*
34. *Cold oil*
35. *Planetary gear failure - replace*
36. *Incorrect reverse band adjustment - readjust*
37. *Relief valve or oil discharge passage plug leak*
38. *Reverse clutch lever not free*
39. *High rotational speed in reverse*

TROUBLESHOOTING CHART

COMPLAINTS and SYMPTONS	REMEDY	
	TRANSMISSION INSTALLED ON ENGINE	TRANSMISSION REMOVED FROM ENGINE
Internal and External Leaks		
Oil leaks at control valve	2 , 1 , 3 , 5 , 7 , 8	
Oil leaks at pump		1, 2, 4, 8, 37
Oil on exterior of transmission	6, 3*	2, 1, 5, 3, 4, 8, 7
Oil leaks at output housing		2, 1, 4, 5, 8
Water in transmission oil	9	
Transmission Malfunctions in All Ranges		
No oil pressure	10, 12	11, 15
Low oil pressure	12, 14	13, 16, 15
High oil temperature	10, 14, 6, 18	
Does not shift	30 , 31, 32	
Transmission Malfunctions in Forward Range		
Low oil pressure	12, 14	13, 19, 21, 16, 5, 1, 15
Forward clutch engages improperly	31, 30	19, 20, 21, 22, 23, 24
Forward clutch drags	31	22, 23, 24
Transmission Malfunctions in Reverse Range		
Low oil pressure	12, 14	13, 16, 5, 1, 15
Reverse clutch engages improperly	31, 30 , 36	1, 26, 25, 35
Transmission Malfunctions in Neutral		
Output shaft drags excessively in forward rotation	31	22, 23, 24
Output shaft drags excessively in reverse rotation	38*, 36	39, 25
Miscellaneous Transmission Problems		
Oil foaming	17	1, 13
Gear noise in reverse		27, 35
Pump noise	14	13
Flywheel drive plate noise or failure		29, 28
High oil pressure	33, 34, 12	15
Smoking	14, 17, 38*, 31 , 39	

** If installation allows access, otherwise remove transmission.*

TRANSMISSION

REMOVAL

1. Shift transmission into reverse gear.
2. Remove engine and transmission from boat (refer to Section 2J).

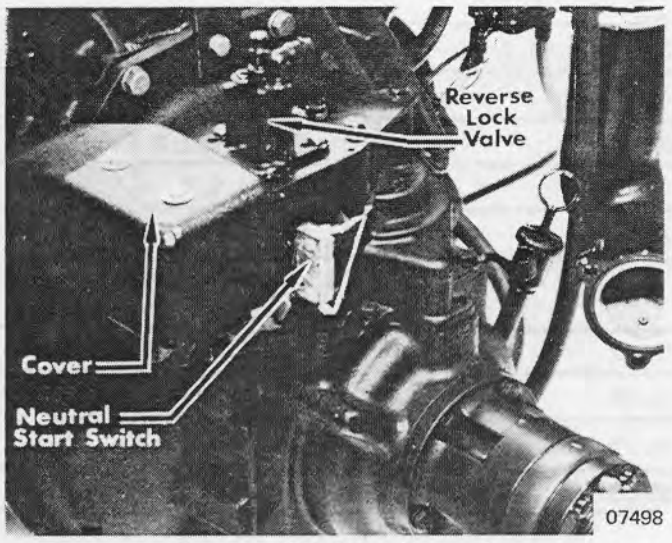

Figure 1. Shift Cover Removal

3. Remove actuator cover (Figure 1) and shifting leads. (Figure 2)
4. Remove hydraulic hoses from reverse lock valve.

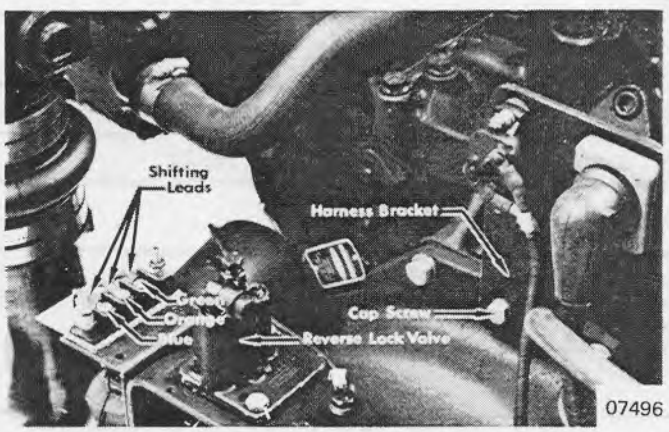

Figure 2. Harness Bracket and Shift Wire Removal

5. Remove 2 cap screws (Figure 2) and position harness bracket away from transmission.
6. Remove yellow neutral start wire from terminal block on flywheel housing and yellow/black wire from starter solenoid.

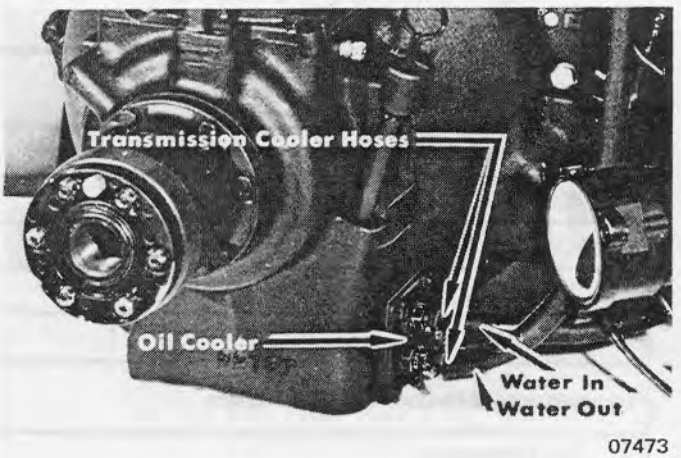

Figure 3. Transmission Hose Removal

7. Remove 2 starter motor attaching bolts.
8. Remove 2 flywheel dust cover cap screws.
9. Loosen clamps and remove cooler hoses from transmission cooler. (Figure 3)
10. Remove 6 transmission attaching cap screws and pull transmission straight back and off engine.
11. Install transmission in suitable stand.
12. Remove drain plug and drain oil from transmission. Check oil for metal particles and condensation. (Figure 4)

NOTE: All transmission parts should be thoroughly cleaned with solvent. Use compressed air to dry all parts. DO NOT use rags, as lint may cause a transmission malfunction.

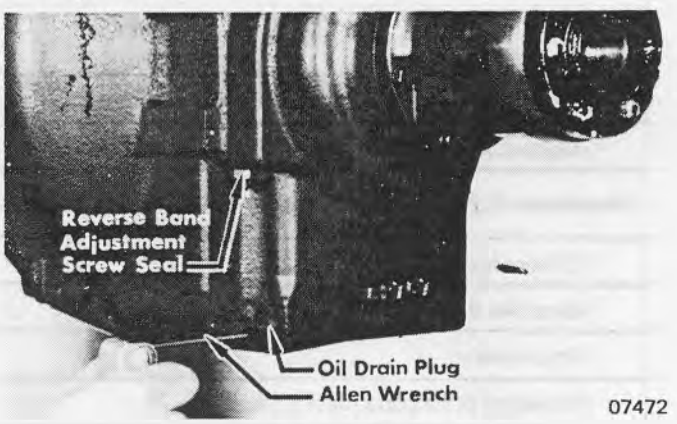

Figure 4. Draining Transmission

DISASSEMBLY and REPAIR

NOTES:

a. *Use Loctite Hydraulic Sealant on all plugs, cap screws and nuts. Using any other type Loctite may cause transmission failure.*

b. *All transmission parts should be thoroughly cleaned with solvent. Use compressed compressed air to dry all parts. DO NOT use rags, as lint may cause a transmission malfunction.*

c. *All O-rings, seals and teflon seal rings, which are worn or damaged, must be replaced.*

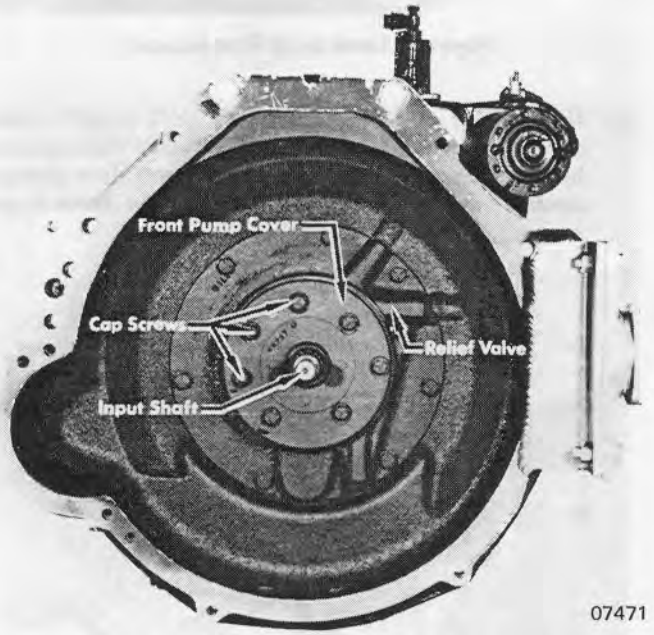

Figure 1. Removing Front Cover

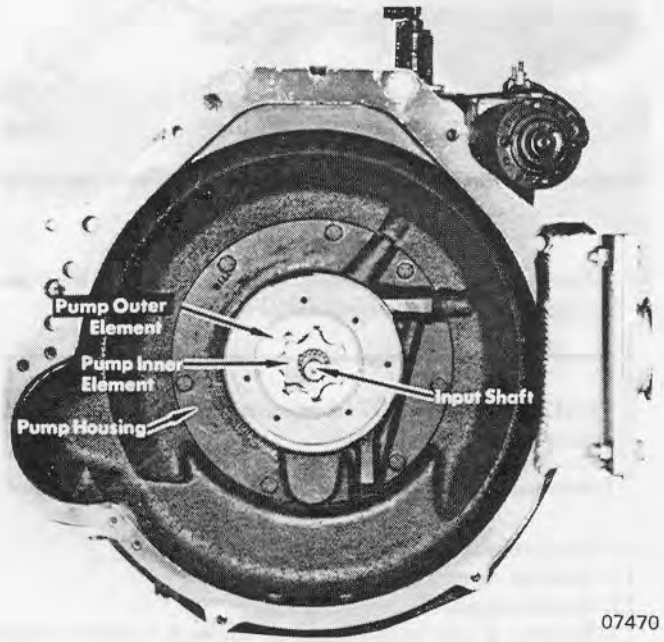

Figure 2. Removing Pump Elements

1. Remove 7 cap screws from front pump cover (Figure 1), then remove cover and "O" ring. Use caution when removing cover so that oil seal is not damaged. Mark pump element location with grease pencil. Remove pump inner element (Figure 2) by inserting an allen wrench behind inner element, then pulling. Be careful not to damage inner pump element. Remove outer element.

NOTE: Check input pump cover for wear. Inspect oil seal in cover.

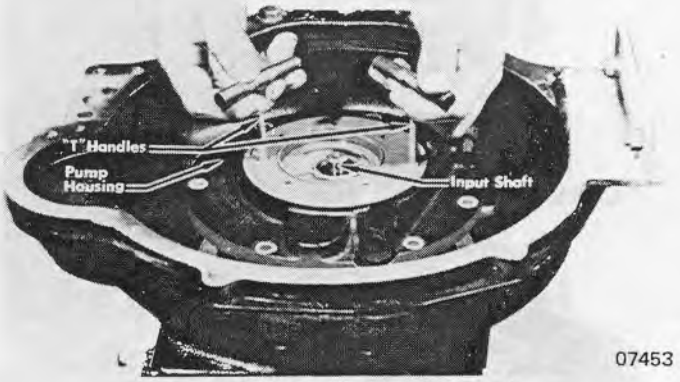

Figure 3. Pump Housing Removal

2. Remove key from input shaft before removing pump housing. Discard key. Remove 7 cap screws and install "T" handles in pump housing. (Figure 3) Pull pump housing straight out. Remove 4 "O" rings.

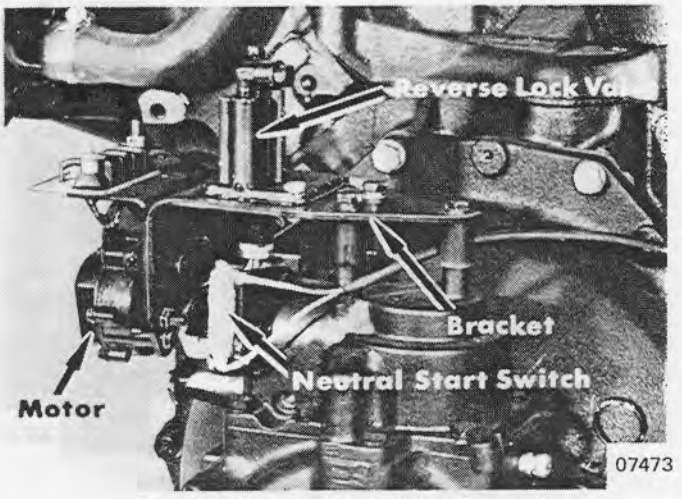

Figure 4. Reverse Lock Valve Removal

3. Remove cap screws and nuts and remove reverse lock valve if necessary for repair. Remove 4 cap screws, then remove actuating motor and bracket. Remove 2 screws from neutral start switch and remove switch. (Figure 4)
4. Remove control valve housing by removing 7 cap screws and "J" clip. Tap housing with mallet to loosen. Reach under control valve housing and hold with upward force on reverse clutch lever so that the accumulator piston will not fall out. (Figure 5) Remove gasket and "O" rings.
5. Remove reverse clutch link from reverse clutch band through control valve housing opening. (Figure 5)

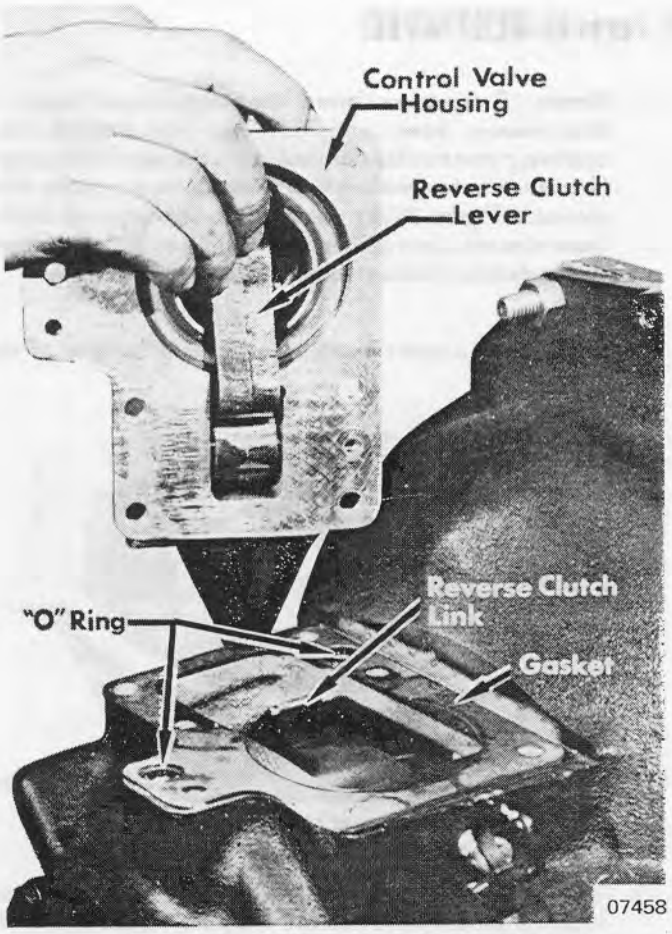

Figure 5. Control Valve Housing Removal

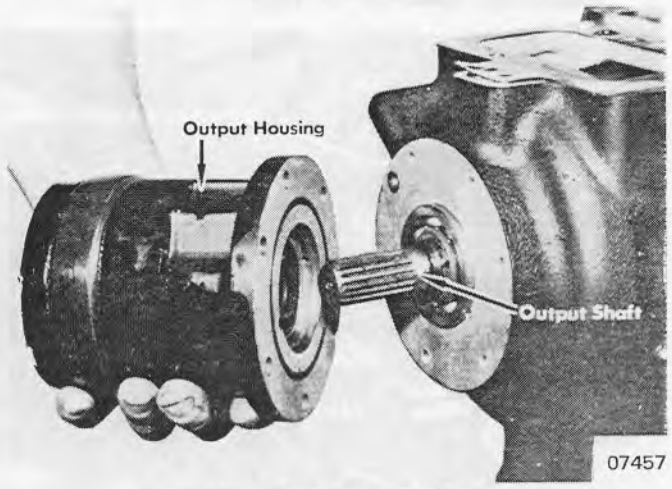

Figure 6. Output Housing Removal

6. Remove 6 cap screws, then remove output housing (Figure 6) and "O" rings. Remove plain washer and "O" ring from inside of output housing. Note that washer and "O" ring will be loose inside housing.
7. Remove snap ring from output shaft with Snap Ring Pliers (C-91-24283). (Figure 7)

CAUTION: DO NOT drag snap ring across output shaft sealing surface.

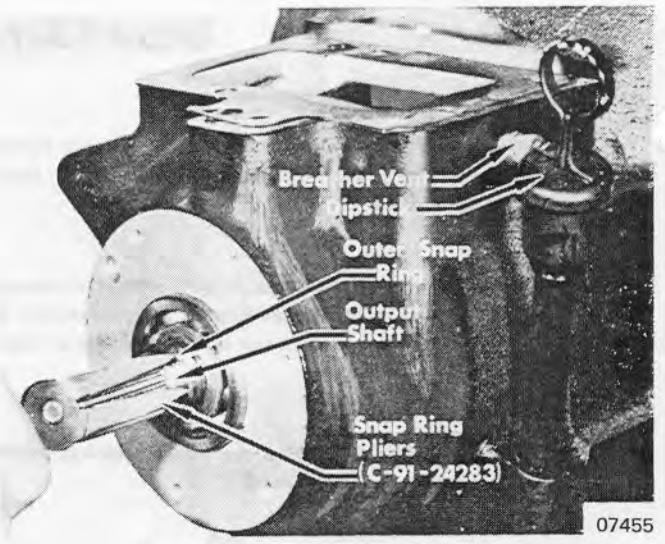

Figure 7. Outer Snap Ring Removal

8. Use suitable tool to press output shaft (Figure 8) until solid resistance is felt. This indicates that inner snap ring has dropped into outer snap ring groove. Move planetary assembly toward output end to remove bearing from housing. (Figure 9)

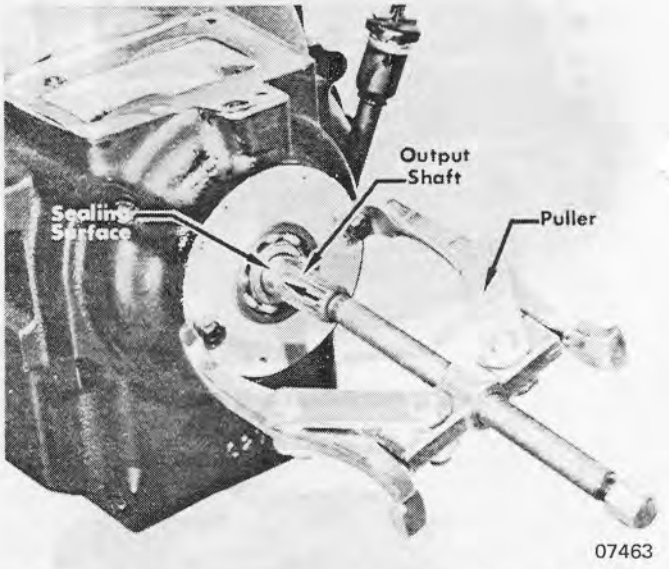

Figure 8. Pressing Inner Snap Ring into Outer Snap Ring Groove

9. Remove rear output bearing. (Figure 9) Remove inner snap ring with Snap Ring Pliers (C-91-24283).

CAUTION: DO NOT drag snap ring across output shaft sealing surface.

10. Remove planetary assembly.
11. Remove reverse band and anchor strut.
12. Remove dipstick.
13. Remove 4 cap screws from oil cooler and remove cooler. (Figure 3 in "Removal")

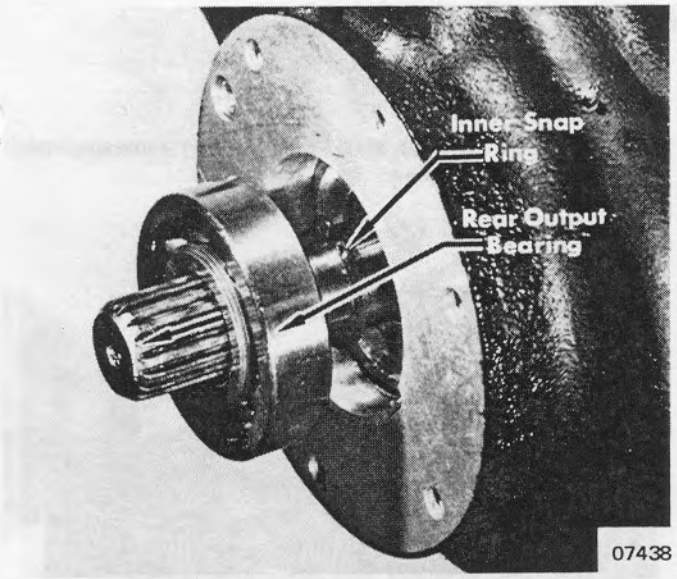

Figure 9. Snap Ring and Bearing Removal

14. Remove allen head screw, then remove oil pickup assembly and "O" ring. (Figure 10)

IMPORTANT: Lockwasher (located below allen head screw) is a special lockwasher. DO NOT use any other size lockwasher.

15. Remove breather vent and clean. (Figure 7)
16. Inspect reverse band adjustment screw seal. (Figure 4 in "Removal")

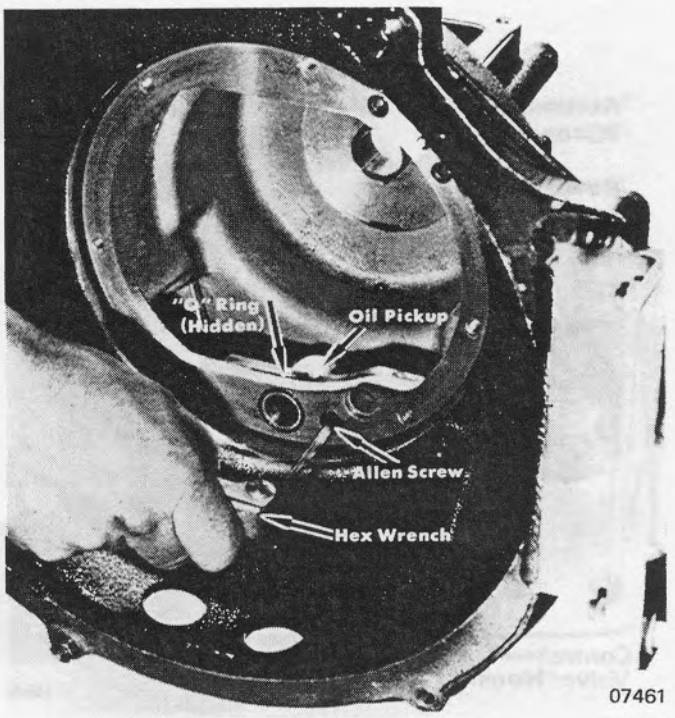

Figure 10. Oil Pickup Removal

CONTROL VALVE HOUSING REPAIR

Figure 1. Accumulator Piston Removal

1. Pull out accumulator piston. (Figure 1)
2. Press retainer down on press with Piston Housing Compressor and remove snap ring. (Figure 2)
3. Remove retainer, servo spring and servo piston with check valve and spring. Check "O" ring on servo piston for wear. (Figures 3 and 4)

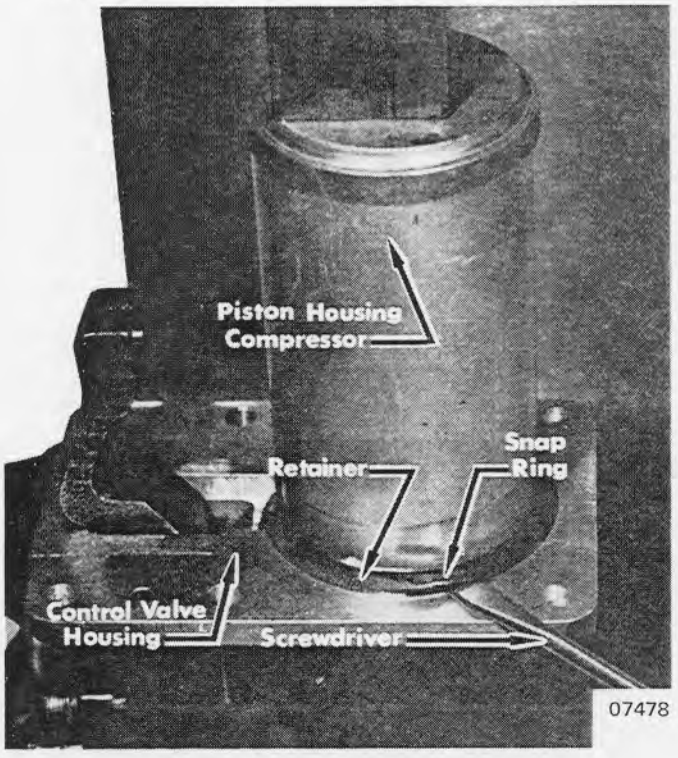

Figure 2. Snap Ring Removal

4. Reverse clutch lever may be replaced by removing welch plug, pin and bushing.

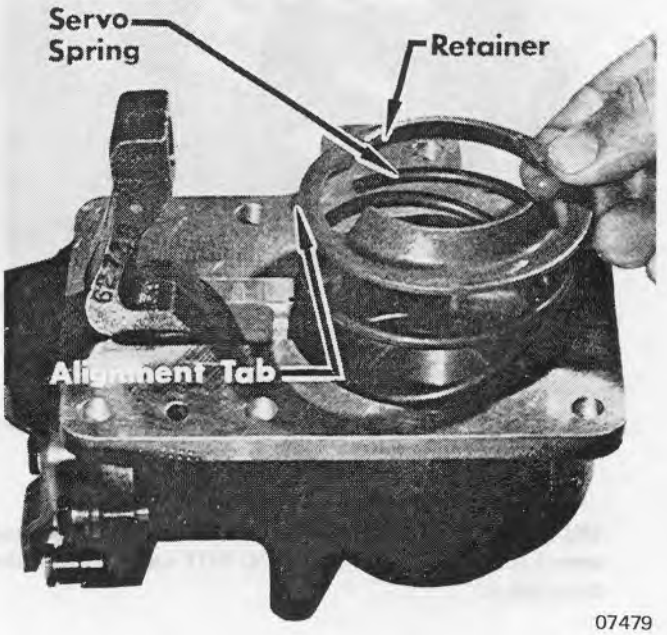

Figure 3. Servo Spring Removal

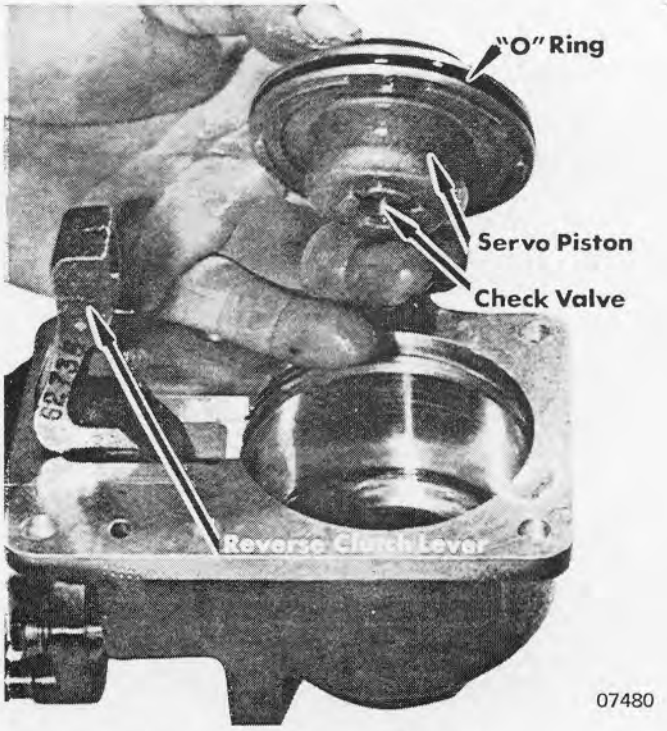

Figure 4. Servo Piston Removal

5. Remove 2 screws and remove control valve cap assembly. Note location of special screw. (Figure 5)
6. Remove control disc from control valve housing.

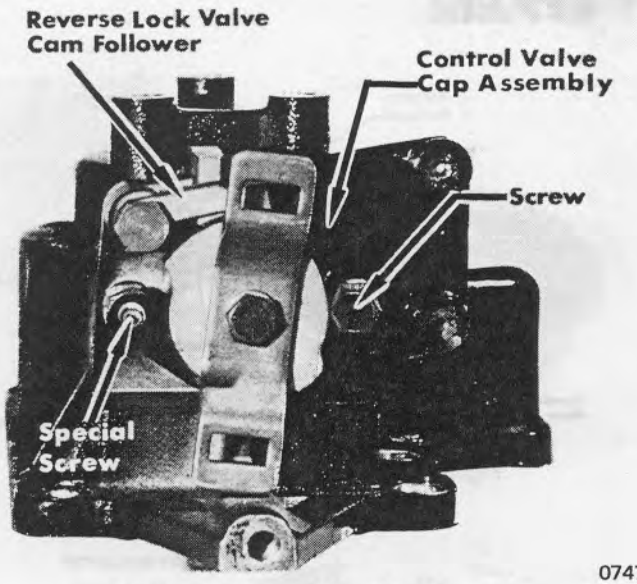

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Figure 5. Control Valve Cap Removal

7. When center cap screw from control shaft is removed, assembly pulls apart. Check "O" rings. (Figure 6)
8. Inspect .050" washer on control shaft. Remove roll pin and replace washer, if bent.

NOTE: DO NOT remove washer from control shaft unless replacement is necessary.

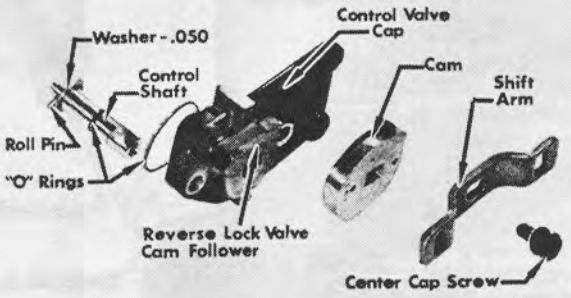

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Figure 6. Control Valve Disassembly

PUMP HOUSING RELIEF VALVE REPAIR

1. Remove relief valve plug, "O" ring, spring and relief valve piston. (Figure 7)
2. Inspect relief piston and passage for burrs or wear. Check plug and "O" ring for damage.
3. Remove oil discharge passage plug and check "O" ring. (Figure 7)

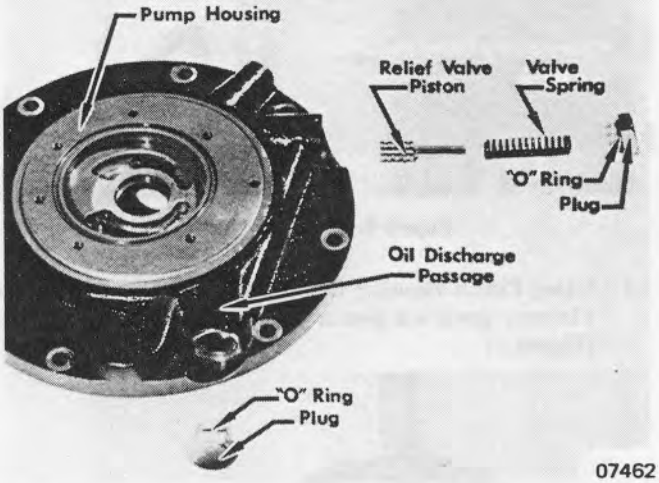

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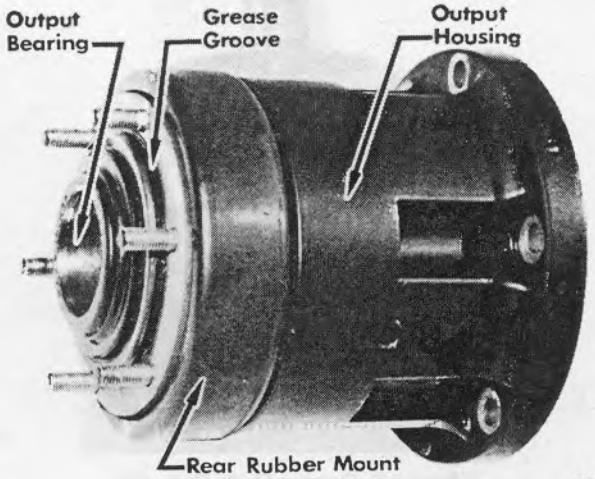
Figure 7. Relief Valve Removal

OUTPUT HOUSING REPAIR and REASSEMBLY



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1. Remove 6 nuts from bearing retainer and remove retainer.

   NOTE: Retainer studs must protrude 5/8" ± 1/16" from output housing.

2. Inspect bearing for roughness and excessive play. DO NOT remove bearing unless replacement is necessary. Install new bearing with grease groove out. (Figure 8)
3. Inspect rear rubber mount and replace if cracked or torn.
4. Install bearing retainer with 6 nuts. Grease fitting should be "up".

   NOTE: DO NOT tighten 6 nuts until engine is installed in boat.

5. Lubricate rubber mount when installing in boat.

Figure 8. Output Bearing Removal

PLANETARY REPAIR

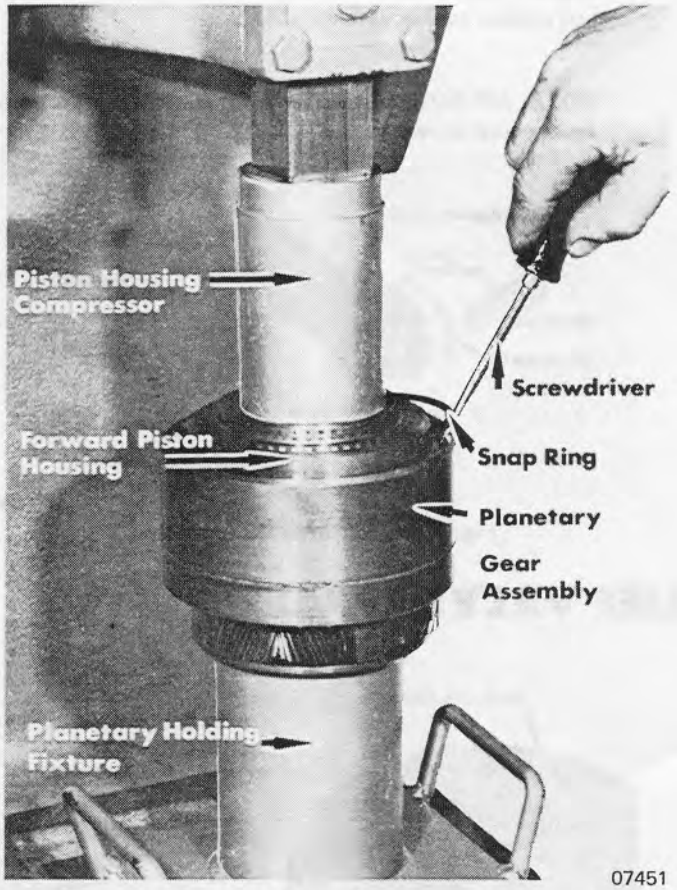

Figure 1. Snap Ring Removal

1. Using Piston Housing Compressor and Planetary Holding Fixture, press on piston housing and remove snap ring. (Figure 1)

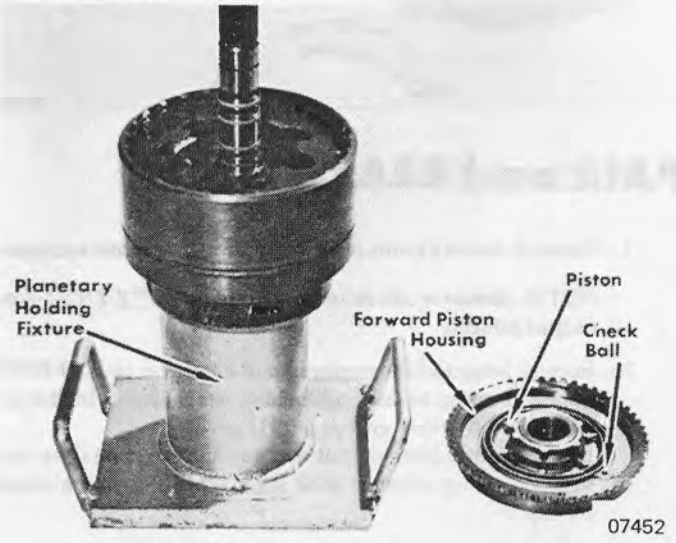

Figure 2. Forward Piston Housing Removal

2. Remove forward piston housing from planetary. (Figure 2)
3. Remove piston from housing by covering 2 holes in center of piston housing and forcing compressed air thru third hole. Be sure to check that check ball in piston is free. (Figure 2)

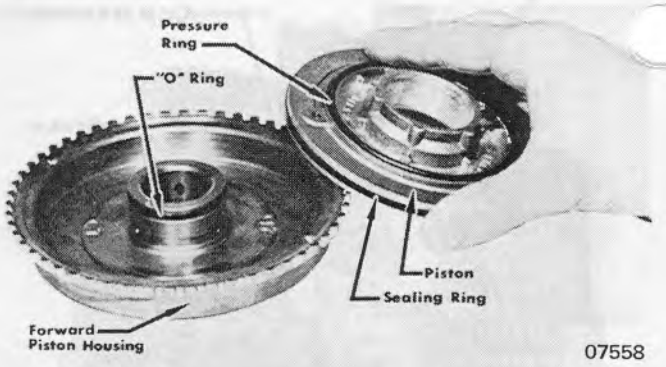

Figure 3. Forward Piston and Housing

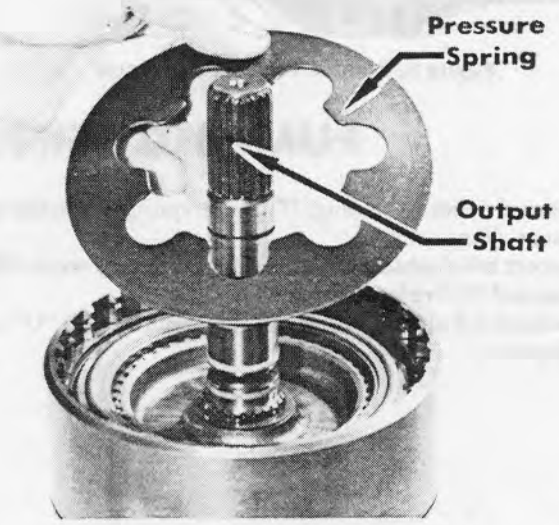

Figure 4. Pressure Spring Removal

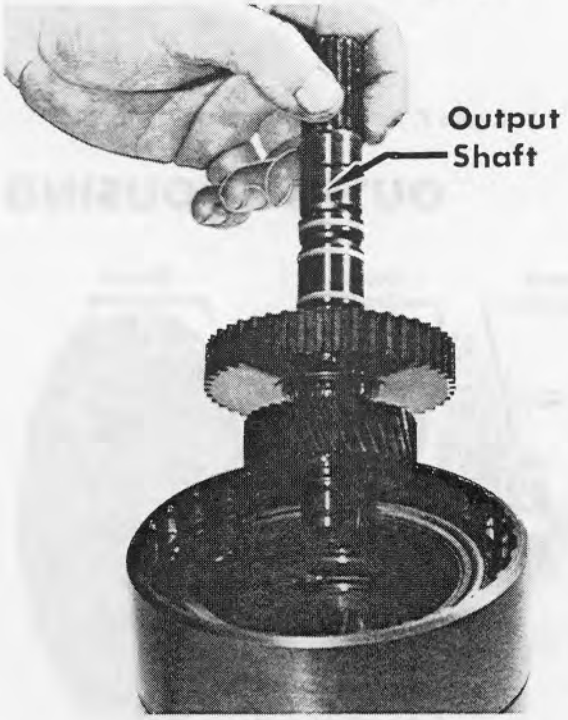

Figure 5. Output Shaft Removal

4. Inspect sealing ring on piston and "O" ring on piston housing and replace if cut or torn. (Figure 3)
5. Check bearing in piston housing for roughness and excessive play.

NOTE: Be sure that piston housing bearing is pressed all-the-way into housing.

6. Remove pressure spring. (Figure 4)
7. Remove output shaft and thrust bearing. (Figure 5)
8. Lift pressure plate to snap ring and measure clutch pack clearance. Clearance should be .020-.050" (.51-1.27mm) between clutch plates and pressure plate. (Figure 6)

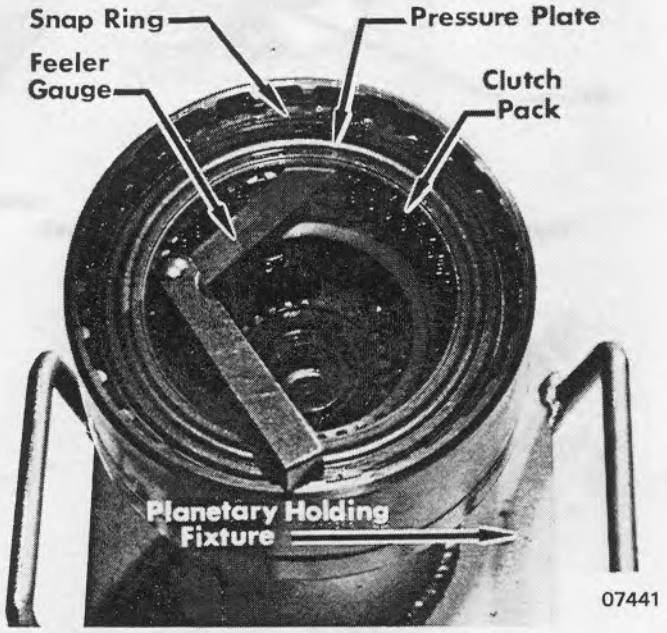

Figure 6. Determining Clutch Pack Clearance

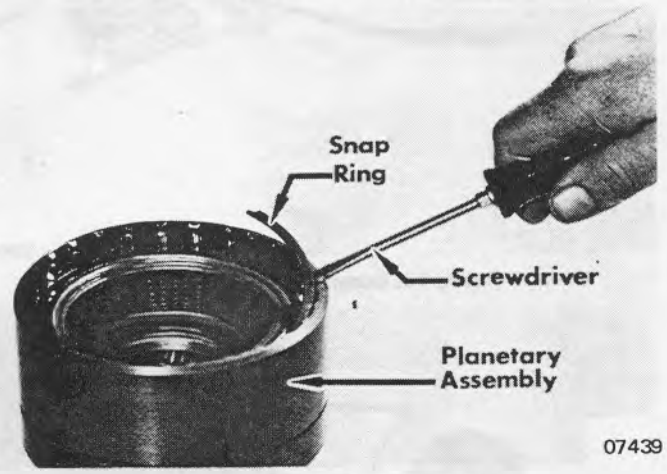

Figure 7. Snap Ring Removal

NOTE: If clutch pack clearance is not within tolerances, fiber-faced disc(s) of correct thickness must be inserted during reassembly to obtain the proper clearance.

9. Remove snap ring (Figure 7), pressure plate, clutch pack and thick spacer plate. (Figure 8) Check plates for flatness.

IMPORTANT: All plates must be checked for flatness. Plates must be replaced if they are warped.

10. Remove input shaft and thrust bearing. (Figure 9)
11. Inspect front planetary bearing (Figure 9) and replace if necessary.
12. Check the 3 short planetary gears for end clearance. (Figure 9) Replace planetary assembly if excessive movement is found.

NOTE: Excessive movement of small planetary gears would occur if needle bearings are visible.

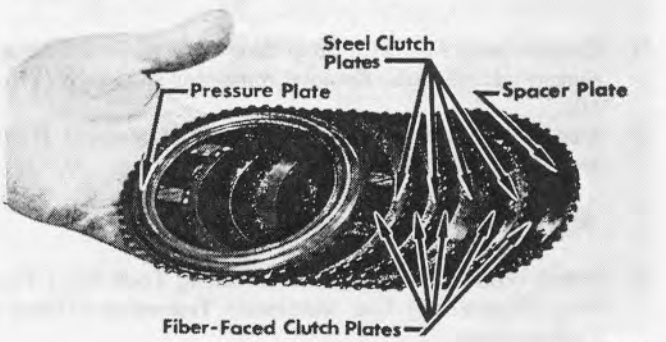

Figure 8. Clutch Pack

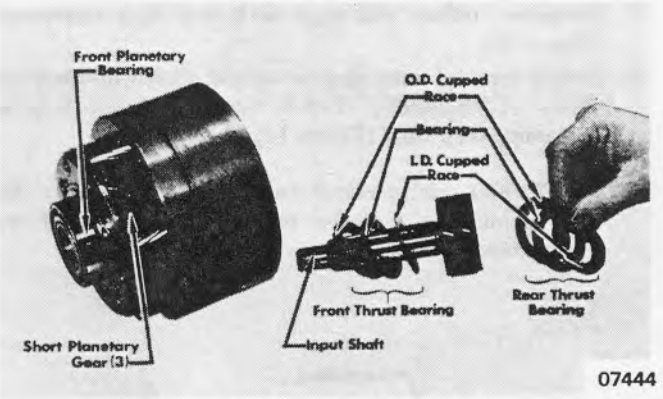

Figure 9. Input Shaft Removal

OUTPUT SHAFT REPAIR and REASSEMBLY

1. Remove snap ring with Snap Ring Pliers (C-91-24283) and remove clutch hub. Remove remaining snap ring. (Figure 10)
2. Inspect teflon seal rings (located on output shaft). If rings are cut or scratched, remove and discard.

   NOTE: Replace teflon seal rings in a set only.

3. Install teflon seal rings onto Installing Tool, using Taper Plug. (Figure 11) Use Automatic Transmission Fluid to lubricate rings.
4. Push teflon seal rings from Installing Tool onto output shaft. (Figure 12) Compress rings with fingers before using Seal Ring Compressor Tool.
5. Compress teflon seal rings with Seal Ring Compressor. (Figure 13)
6. Install forward snap ring on output shaft with Snap Ring Pliers (C-91-24283). Install forward clutch hub and remaining snap ring. (Figure 14)

   NOTE: Flat side of clutch hub must be toward gear. Snap rings should be installed with sharp edges away from clutch hub.

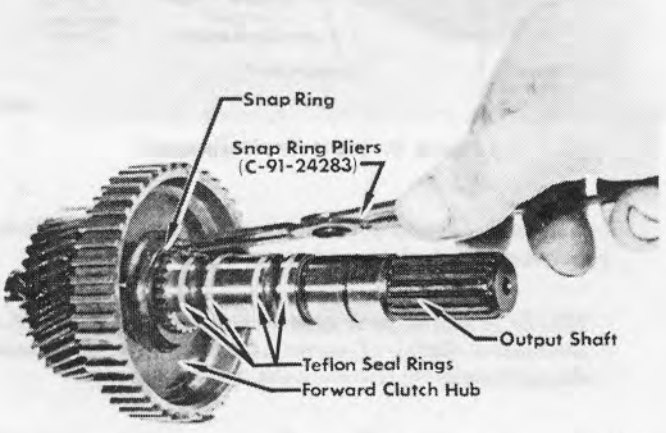

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Figure 10. Removing Snap Ring from Output Shaft

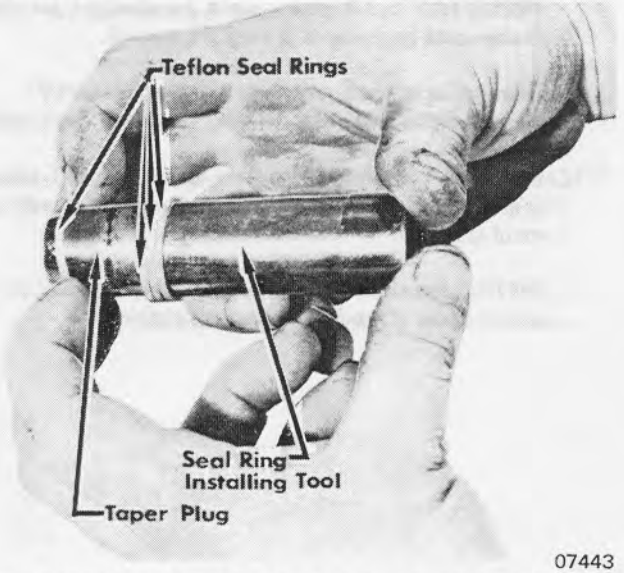

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Figure 11. Teflon Seal Ring Installation on Installing Tool

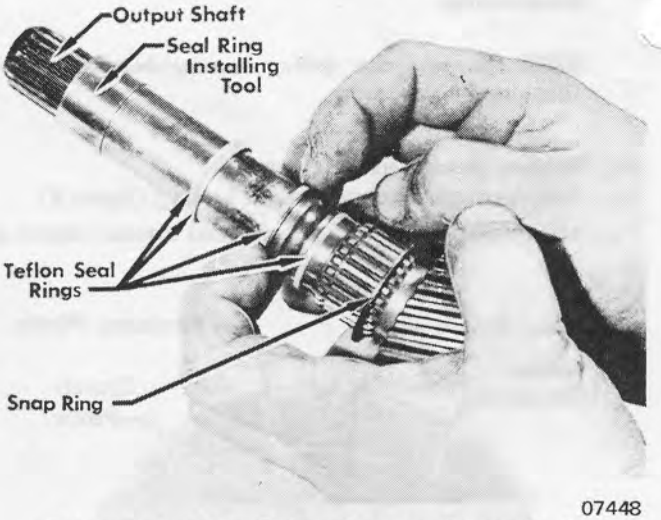

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Figure 12. Installing Teflon Rings on Output Shaft

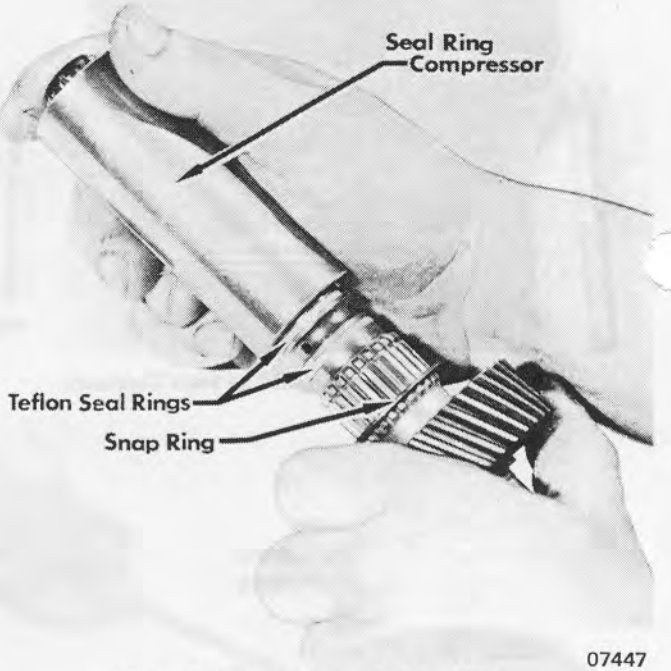

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Figure 13. Compressing Teflon Rings

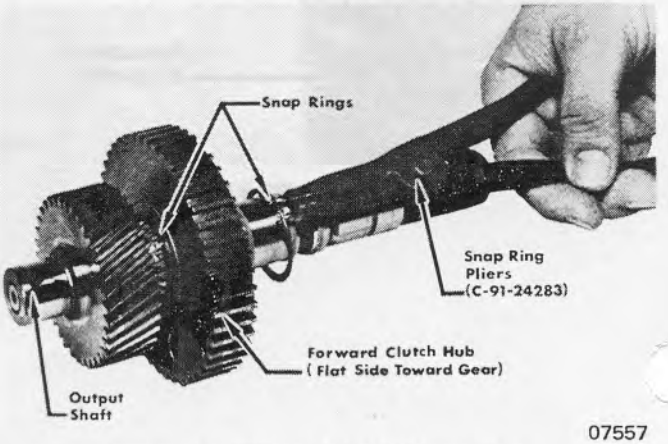

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Figure 14. Output Shaft Reassembly

CONTROL VALVE HOUSING REASSEMBLY

NOTES: Refer to "Specifications", Section 8, for torque specifications.
Lubricate all "O" rings during reassembly with Multi-purpose Lubricant (C-92-49588) to prevent "O" ring damage.

1. Install "O" ring on servo piston. (Figure 4 in "Control Valve Disassembly") Install accumulator piston in servo piston. (Figure 15)

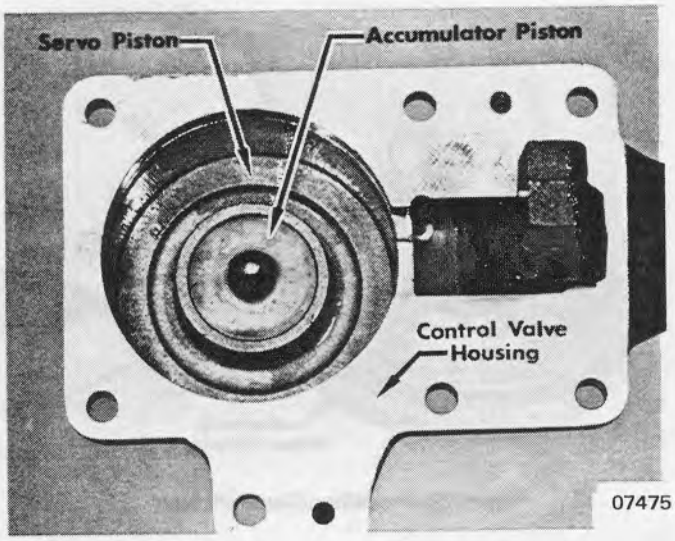


Figure 15. Servo Piston Reassembly

2. Lubricate control valve housing and servo piston with Automatic Transmission Fluid. Install servo piston in control valve housing. (Figure 15)
3. Install servo piston retaining spring, spring retainer and snap ring (Figure 3 in "Control Valve Repair"), using Piston Housing Compressor. (Figure 2 in "Control Valve Repair")
4. Lubricate control valve housing with Automatic Transmission Fluid and install control disc as shown in Figure 16.
5. Install "O" ring on control shaft. (Figure 6 in "Control Valve Repair")
6. Install control shaft in control valve cap. Install "O" ring on control valve cap. (Figure 6 in "Control Valve Repair")
7. Attach cam and shift arm to control shaft with cap screw and washer. (Figure 6 in "Control Valve Repair")

   NOTE: The word "OUT" stamped on cam must be "out". (Figure 17)

8. Install control valve cap with 2 screws.

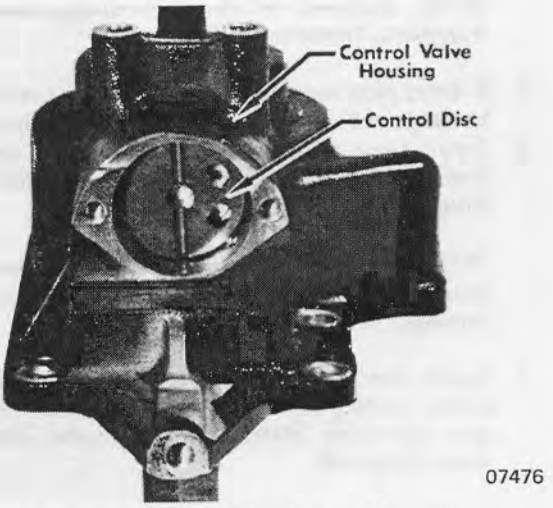


Figure 16. Control Disc Reassembly

NOTE: When roll pin in control shaft is aligned with slot in control disc, the cam must be positioned with the word "OUT" in the "up" position. Make sure that special screw is in proper location and that reverse lock valve cam follower turns freely.

9. Install neutral start switch on control valve assembly.

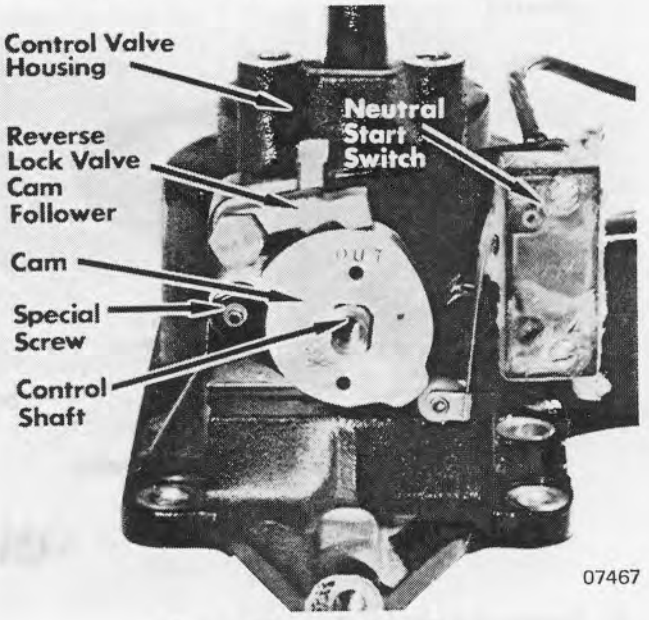


Figure 17. Cam Reassembly

PUMP HOUSING RELIEF VALVE REASSEMBLY

1. Install "O" ring and large plug in oil discharge passage. (Figure 7 in "Pump Housing Repair")
2. Install relief valve piston, spring, "O" ring and plug. (Figure 7 in "Pump Housing Repair")

PLANETARY REASSEMBLY

NOTE: Lubricate all bearings during reassembly with Automatic Transmission Fluid.

1. If front planetary bearing was removed, press bearing onto housing until inner race is firmly seated. (Figure 9)
2. Install front thrust bearing in planetary. Inspect needle bearing in input shaft and install input shaft. Install rear thrust bearing. (Figure 9)

   NOTE: Install thrust bearings with cupped races exactly as shown in Figure 9. Cupped surfaces must be toward bearings.

3. Install clutch back-up spacer, flat side up. Install clutch plates, starting with fiber-faced plate and alternating steel and fiber-faced plates. Install pressure plate, flat side down. (Figure 8)

   NOTE: Lubricate clutch plates with Automatic Transmission Fluid during assembly. If new fiber-faced plates are used, soak in Automatic Transmission Fluid ½-hour before installation.

4. Install snap ring and check clutch pack clearance. (Figure 6) Clearance should be .020"-.050" (.51-1.27mm). Install correct fiber-faced disc(s) to obtain exact clearance.
5. Install output shaft assembly in clutch pack so that clutch hub is flush with outer-most fiber-faced clutch disc. (Figure 5)

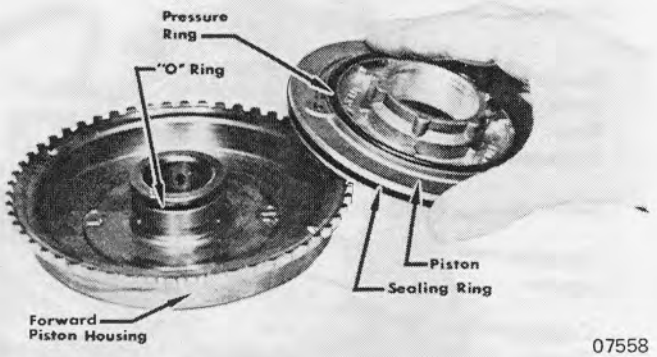


Figure 18. Forward Clutch Reassembly

6. Install pressure spring, concave (hollowed) side down (Figure 2)

   IMPORTANT: If pressure spring is installed improperly, transmission will not operate.

7. Install sealing ring and pressure ring on forward clutch piston.(Figure 18)
8. Install "O" ring in piston housing and lubricate housing with Multipurpose Lubricant (C-92-49588). (Figure 18)

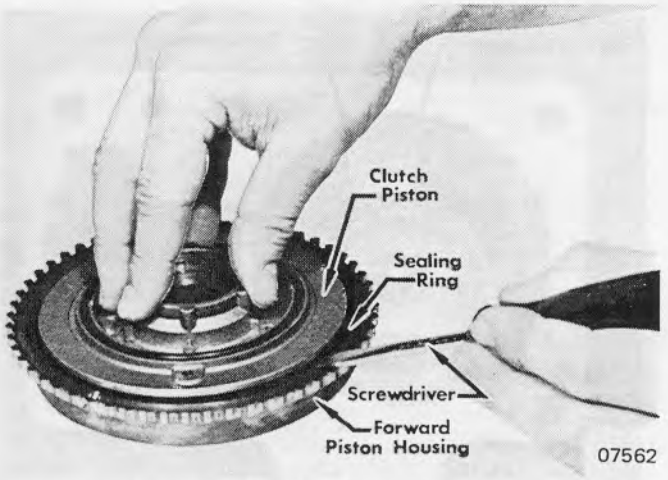


Figure 19. Installing Clutch Piston

9. Install piston in piston housing. (Figure 19)

   NOTE: Work piston sealing ring in with screwdriver while pressing piston into housing. (Figure 19)

10. Lubricate output shaft with Automatic Transmission Fluid and install clutch piston assembly in planetary drum.

    NOTE: Make sure that pressure ring (Figure 18) does not drop off piston assembly. Pressure ring must seat against pressure spring. (Figure 2)

11. Using Piston Housing Compressor and Holding Fixture, press piston housing down, then install snap ring. (Figure 1 in "Planetary Repair")
12. Check for free rotation of input and output shafts.

OIL COOLER

1. Inspect oil cooler for cracks or holes.
2. Check oil cooler for leaks. Pressurize oil cooler to approximately 40 P.S.I. with compressed air.
3. Remove gasket from oil cooler and clean gasket surface.

TRANSMISSION REASSEMBLY

NOTES: Use Loctite Hydraulic Sealant on all plugs, cap screws and nuts. Using any other type Loctite may cause transmission failure.

Refer to "Specifications", Section 8, for torque specifications.

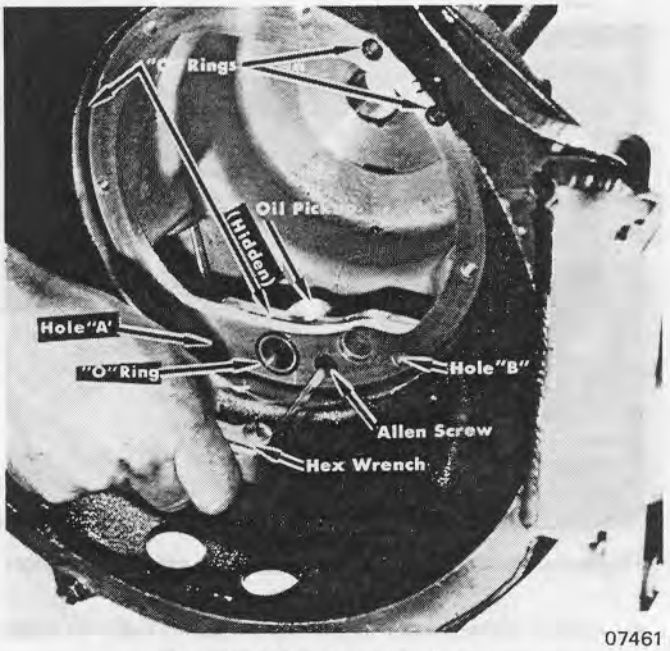


Figure 1. Oil Pickup Installation

1. Install "O" ring in groove on oil pickup tube assembly with Multipurpose Lubricant (C-92-49588). Position oil pickup in housing. Insert two 5/16-18x5/8 cap screws into holes "A" and "B" to align assembly. (Figure 1) Secure oil pickup with special lockwasher and allen head screw. Remove cap screws.

   NOTE: Lockwasher on allen screw is .047"(1.2mm) thick. DO NOT replace with another size lockwasher. Be sure that "O" ring does not fall from oil pickup during reassembly.

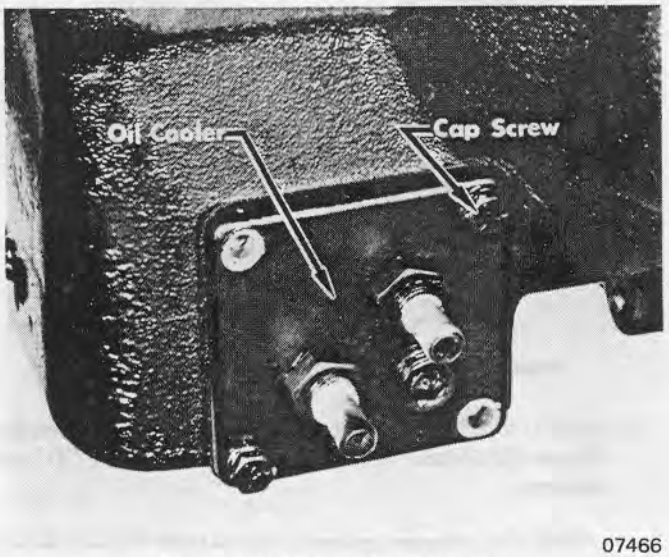


Figure 2. Oil Cooler Installation

2. Using a new gasket, install oil cooler with 4 cap screws as shown in Figure 2.
3. Install breather vent.

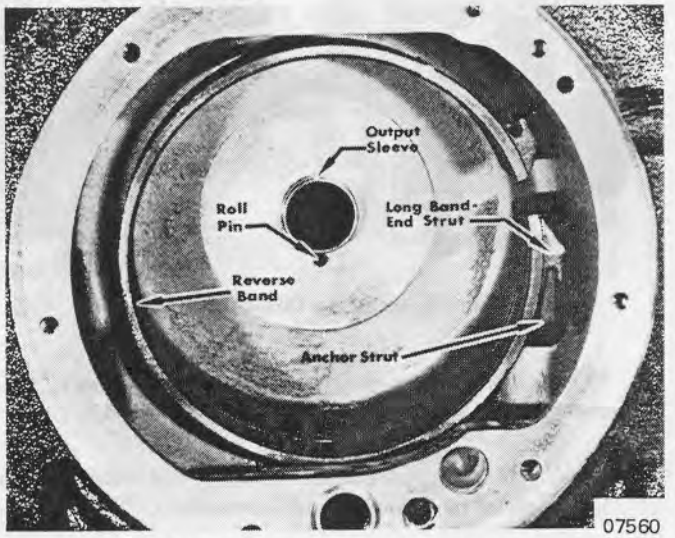


Figure 3. Reverse Band Installation

4. Install reverse band adjustment anchor screw so that anchor strut is clear of housing. Install reverse band with long band - end strut supported on anchor strut. (Figure 3)

   NOTE: Anchor strut notch must match tang in reverse band. Lubricate reverse band and output sleeve with Automatic Transmission Fluid.

CAUTION: Oil passage in output sleeve and hole in housing must line up. Roll pin must NOT be replaced with a solid pin. DO NOT remove output sleeve.

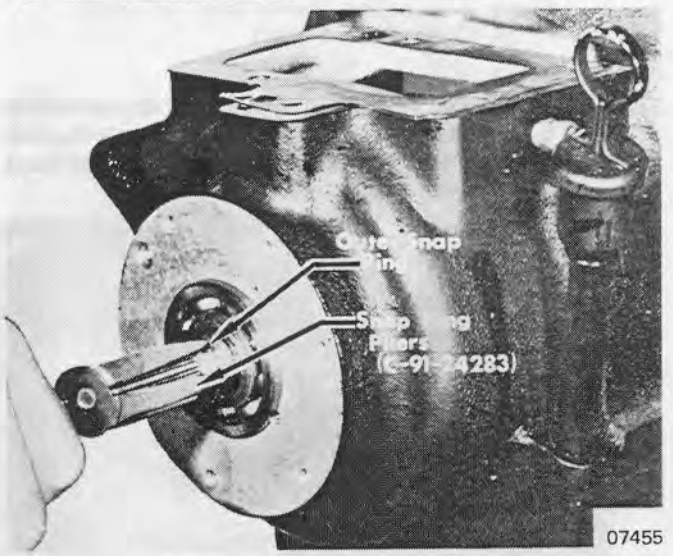


Figure 4. Installing Outer Snap Ring

5. Install planetary assembly in housing. Install inner snap ring, bearing (with number out) and outer snap ring. (Figure 4) Install bearing lubricating passage "O" ring. (Figure 5)

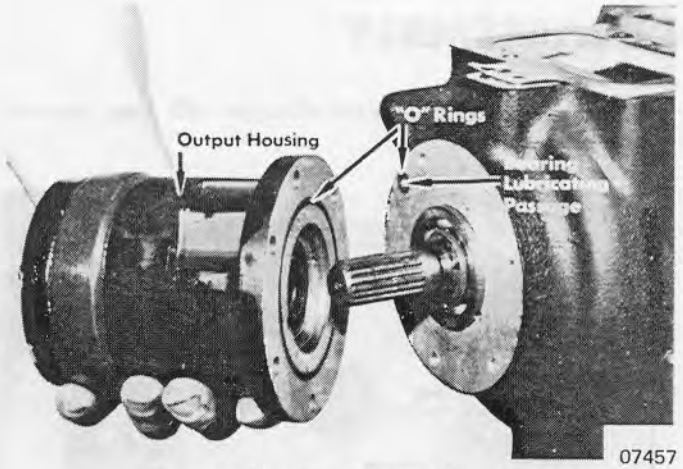


Figure 5. Installing Output Housing

NOTE: Install snap rings with sharp edges "away" from bearing. DO NOT drag snap rings on output shaft.

6. Install "O" ring in output housing and attach output housing with 6 cap screws and lockwashers. (Figure 5)

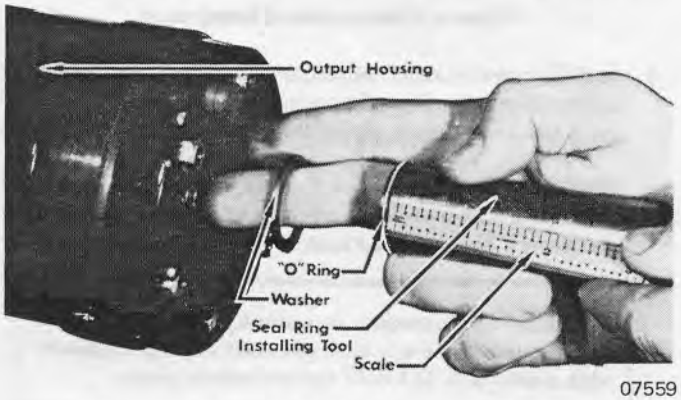


Figure 6. Installing Washer and "O" Ring on Output Shaft

7. Install washer on ouput shaft. Install "O" ring on Installing Tool and, using scale, push "O" ring onto output shaft. Use Installing Tool to work "O" ring onto shaft as far as it will go. (Figure 6)

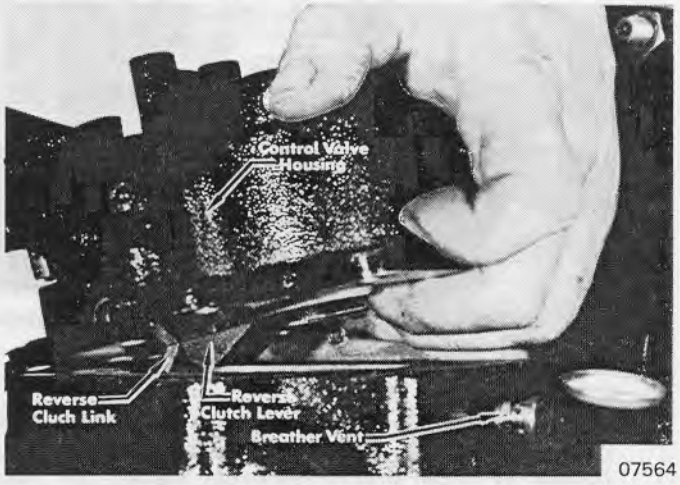


Figure 7. Control Valve Installation

8. Apply Multipurpose Lubricant (C-92-49588) to transmission control valve housing opening to hold new gasket and "O" rings in place. Install reverse clutch link into reverse clutch band. Hold control valve lever up into control valve housing and slide control valve housing onto transmission so that reverse band link and control valve lever mate. (Figure 7)

NOTE: Slot in clutch link must align with tang on reverse band.

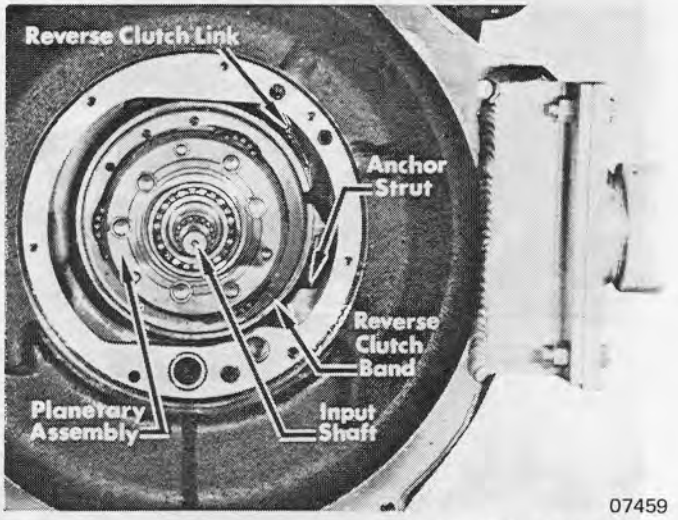


Figure 8. Positioning Reverse Clutch Link and Anchor Strut

9. Secure control valve with 7 cap screws. "J" clip is installed under cap screw closest to dipstick. Check inside transmission to make sure that clutch link, reverse band and anchor strut are in proper position. (Figure 8)

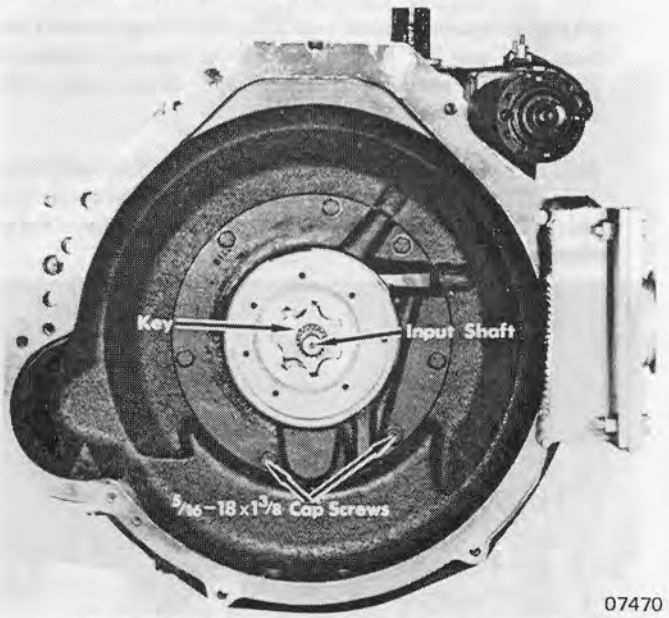


Figure 9. Installing Pump Housing and Elements

10. Install 4 "O" rings and pump housing in transmission. (Figure 9) Secure with 7 cap screws and new "O" ring washers.

NOTE: Two longer cap screws (5/16-18x1-3/8) are located as shown in Figure 9.

11. Position input shaft with keyway "up". Lubricate pump components with Automatic Transmission Fluid. Install new key, inner pump element and outer pump element. (Figure 9)

NOTE: When installing pump elements, align elements with grease pencil mark made in disassembly.

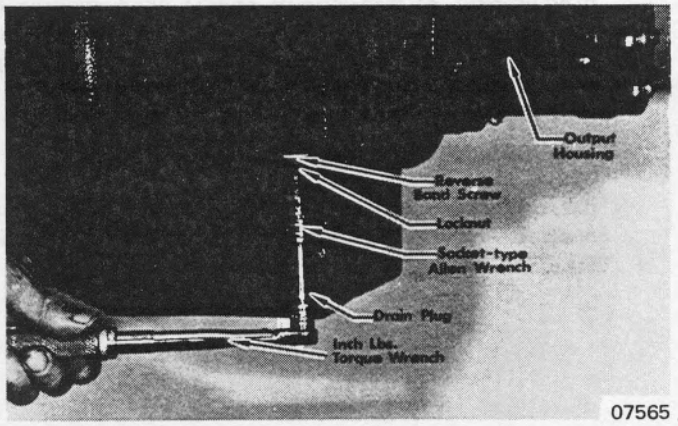


Figure 10. Adjusting Reverse Band

12. Install "O" ring and pump cover with 7 cap screws. (Figure 1 in "Disassembly")
13. Loosen locknut and torque reverse band screw to 120 in. lbs. (21.3kg/cm) (Figure 10) Back off 1-1/2 turns and tighten locknut. Re-adjust reverse band screw after transmission has been run in reverse and forward for one minute.
14. Install motor bracket, actuating motor and terminal strip on control valve housing.

    NOTE: Ground wire from actuating motor must be attached to bracket cap screw.

15. Install reverse lock valve.
16. Install oil drain plug.
17. Fill transmission with 2 quarts of Automatic Transmission Fluid.

CAUTION: DO NOT mix types or brands of Automatic Transmission Fluid.

18. Install dipstick.

INSTALLATION

NOTE: Refer to "Specifications", Section 8, for torque specifications.

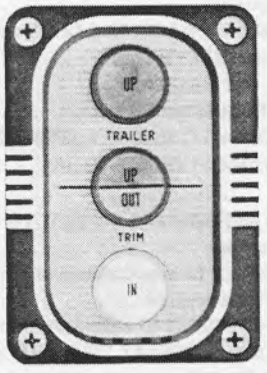
1. Lubricate transmission input splines with Multipurpose Lubricant (C-92-49588).
2. Align input splines with flywheel drive plate of engine. Push transmission ahead and on engine. Install 6 transmission attaching cap screws.
3. Attach cooler hoses to transmission cooler. (Figure 3 in "Removal")
4. Install dust cover and starter motor.
5. Attach yellow neutral start wire to terminal block on flywheel housing and yellow/black wire to starter solenoid.
6. Secure harness bracket to transmission. (Figure 2 in "Removal")
7. Attach hydraulic hoses to reverse lock valve.
8. Install shifting leads (Figure 2 in "Removal") and actuato cover.

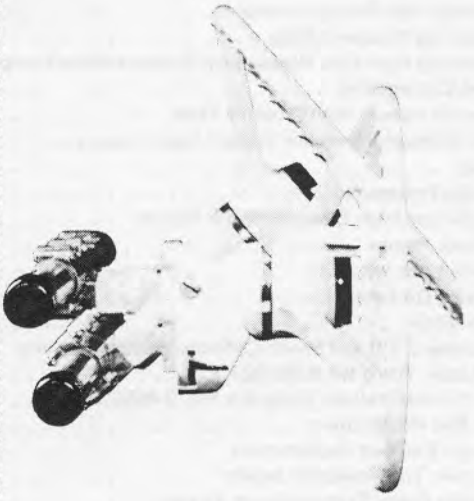
   NOTE: If location of engine in boat does not permit re-adjustment of transmission reverse band after engine installation, engine should be test-run and reverse band should be adjusted before installing engine in boat. (Refer to "Specifications" Section 8.)

9. Install engine in boat. (Refer to Section 2J.)

   NOTE: If engine has not been test-run, then test-run and re-adjust reverse band. (Refer to "Specifications" Section 8.)

MERCRUISER
SECTION 7





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SECTION 7 - ACCESSORIES

MERCRUISER

PART A - POWER TILT and TRIM SYSTEM

MERCURY MARINE

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TROUBLE SHOOTING MERCRUISER POWER TILT

Malfunction	Causes	Remedy
1. Will not tilt to "Up" position.	a. Unit not in neutral or forward gear. b. Internal resistance in cylinders. c. Drive housing interference with gimbal ring or tilt pin. d. Low battery charge. e. Improper wiring. f. Propei switch not operated. g. Solenoid inoperative. h. High resistance or broken or loose connection in wiring, grounds or solenoid. i. Defective key, push button, or rocker switch. j. Oil level low. k. External leaks (fittings, parts leak). l. Too low or no pump pressure. m. Pinched or broken hose.	a. Refer to Owner's Guide for proper operation. b. Replace or repair cylinder. c. Repair or replace. d. Charge battery. e. Trace and correct wiring. f. Refer to Owner's Guide or Service Manual. g. Test, replace defective part. h. Test, replace defective part. i. Test, replace defective part. j. Add oil (Formula 4-20W). k. Tighten fittings or replace if defective. l. Replace pump body assembly. m. Replace hose.
2. Will not return completely to "Down" position.	a. Internal resistance in cylinders. b. Transom angle too great due to bow high attitude. c. Drive housing interference with gimbal ring or tilt pin. d. Air in system. e. Pinched hose.	a. Replace or repair cylinders. b. Shift into forward using propeller thrust to return unit to tilt pin while depressing down button. c. Repair or replace. d. Check for leaks and properly bleed system. e. Replace hose, if necessary.
3. Will not release from full "Up" position.	a. Low battery charge. b. High resistance in wiring, grounds and solenoid. c. Improper wiring. d. Too low or no pump pressure. e. Oil level low. f. Pinched hose.	a. Charge battery. b. Test, replace defective part. c. Trace and correct wiring. d. Replace pump body assembly. e. Add oil (Formula 4-20W) bleed system. f. Replace hose, if necessary.
4. Will not remain in tilted position.	a. External leaks (fittings, parts leak). •b. Pump check valve leak (high pressure). •c. Dirt in system.	a. Tighten fittings or replace if defective. b. Replace pump body assembly. c. Flush system with clean oil, fill and bleed.
5. Oil foams out of pump vent.	a. Oil level low. b. Can not properly installed over oil filter screen.	a. Add oil (Formula 4-20W) and bleed system. b. Reinstall "can" over oil filter screen.
6. Trails out or kicks up in reverse.	a. Reverse lock release lever in released position. b. Damaged or worn parts in reverse lock hook assembly.	a. Refer to Owner s Guide for operation. b. Replace part(s).
7. Pump motor will not run.	a. Low battery charge. b. Improper wiring. c. Defective pump motor. d. High resistance or broken or loose connection in wiring, grounds or solenoid. e. Defective push button or rocker switch. f. Motor overload switch open due to overheating.	a. Charge battery. b. Trace and correct wiring. c. Test, replace defective part. d. Test, replace defective part. e. Test, replace defective part. f. Allow pump to cool - avoid continuous operation.

8. Pump motor runs in "Down" direction only.	a. Improper wiring. b. Proper switch not operated. c. Solenoid inoperative. d. High resistance or broken or loose connection in wiring, grounds or solenoid. e. Defective push button or rocker switch. f. Defective pump motor.	a. Trace and correct wiring. b. Refer to Owner's Guide or Service Manual c. Test, replace defective part. d. Test, replace defective part. e. Test, replace defective part. f. Test, replace defective part.
9. Pump motor runs in "Up" direction only.	a. Improper wiring. b. Proper switch not operated. c. High resistance or broken or loose connection in wiring, grounds or solenoid. d. Defective pump motor. e. Defective push button, or rocker switch.	a. Trace and correct wirina. b. Refer to Owner's Guide or Service Manual. c. Test, replace defective part. d. Test, replace defective part. e. Test, replace defective part.
10. Tilts up while unattended.	a. Moisture in key switch. b. Defective push button switch.	a. Test, replace defective part. b. Test, replace defective part.

•Pump check valve may contain entrapped foreign particles, which can be cleared by operating system up-and-down several times when flushing system. If flushing system fails to correct the problem, the check valve is defective.

Precautions to Observe When Installing, Servicing or Testing Power Trim or Power Tilt Systems with Large Reservoir Pump

1. When installing hydraulic oil lines -
   a. Start threads with fingers so that they will not cross-thread
   b. Do not tighten fittings excessively, as threads may strip. Maximum torque is 125 to 150 in. lbs. (22.2 to 26.6kg cm).
2. Align pump valve body and gear assembly, tightening the 8 screws evenly to prevent pump motor shaft from binding.
3. Use clean, uncontaminated Quicksilver Formula 4 20W Oil to fill the reservoir or when flushing the hydraulic system.
4. Overfilling the pump reservoir and failing to remove the vent seal may damage the "O" ring gaskets, thereby causing a pump body or motor failure.
5. The drive unit must be in the "down" position with hydraulic cylinders collapsed when filling the reservoir. Oil level should be even with the bottom of the oil filler hole.
6. Allow the pump motor to cool at least one minute if the pump stops during excessive use. An internal thermal circuit breaker protects the pump motor.
7. Any modification to the hydraulic system or assemblies without proper authority in writing from Kiekhaefer Mercury will void the warranty.

Warranty on hydraulic pumps will not be honored if -

a. Threads are stripped out of pump housing.
b. Contaminated oil, wrong oil or dirt is found in pump reservoir.
c. Modifications are made to pump which result in its malfunction.

8. Service notes:
   a. Work area must be dirt and lint-free. The slightest amount of dirt may cause pump to malfunction.
   b. Precision fitting of valves and gears requires that the valve body and gear cage assembly or control valve assembly be replaced as a unit.
   c. These hydraulic pumps have a small metal can set over the inlet screen of the valve body and gear assembly. The can must be placed securely over the inlet screen.
   d. Use liquid neoprene sparingly and do not allow it to get into the valve body and gear assembly.
   e. Hydraulic pump motors require moisture-proofing, particularly after repair. To mositure-proof, apply liquid neoprene around pump motor commutator plate edges, around motor frame where it contacts the reservoir and where leads enter motor.

TROUBLESHOOTING MERCRUISER POWER TRIM

GENERAL

Operation	Malfunction	Remedy Reference to Following Charts
1. Operate control panel trim "out" switch(es).*	a. Power Trim motor does NOT run. b. Power Trim motor runs, but drive will NOT trim out c. Trim system operates satisfactorily.	a. No. 7-1-4-5 Electrical; No 1-Mechanical b. No. 1-Hydraulic; No. 1-Mechanical; No. 1-Electrical c. Continue to Step 2
2. Operate control panel tilt "trailer" switch(es).*	a. Power Trim motor does NOT run. b. Power Trim motor runs, but drive will NOT trim up. c. Trim system operates satisfactorily.	a. No. 7-1-4-5 Electrical; No. 1-Mechanical b. No. 1-2 Electrical; No. 1-2 Hydraulic; No. 1-Mechanical. c. Continue to Step 3
3. Operate control panel trim "down" switch(es).*	a. Power Trim motor does NOT run. b. Power Trim motor runs, but drive will NOT trim down. c. Trim system operates satisfactorily.	a. No. 7-6-4-Electrical; No. 3-Hydraulic b. No. 4-Hydraulic; No. 2- Mechanical c. Continue to Step 4
4. Test-run boat	a. Will not hold in reverse or trails out when backing off throttle at high speed. b. Will not hold in forward. c. Out drive thumps when shifted. d. Will trim up or out with drive unit in reverse gear.	a. No. 3-Mechanical; No. 5-7-Hydraulic b. No. 8-Hydraulic c. No. 4-Mechanical; No. 6-Hydraulic d. No. 3-Electrical; No. 5-Mechanical
5. Observe the following:	a. Oil foams out of pump vent. b. Reverse lock valve broken and leaking. c. Trims out or tilts up while unattended.	a. No. 11-Hydraulic b. No. 10-Hydraulic c. No. 8-Electrical

** For operation of control panel switches, refer to Section 1A.*

MECHANICAL

Malfunction	Causes	Remedy
1. Will not trim up or out.	a. Improperly adjusted reverse lock valve. b. Unit not in neutral or forward gear. c. Drive housing interference with gimbal ring or tilt pin.	a. Adjust according to procedure. b. Refer to Owner's Guide. c. Repair or replace.
2. Will not return completely to "Down" position or returns part way with jerky motion.	a. Drive housing interference with gimbal ring or tilt pin.	a. Repair or replace.
3. Will not hold in reverse.	a. Improperly adjusted reverse lock valve.	a. Adjust according to procedure.
4. Out drive thumps when shifted.	a. Improperly adjusted reverse lock valve.	a. Adjust according to procedure.
5. Will trim up or out with drive unit in reverse gear.	a. Improperly adjusted reverse lock valve.	a. Adjust according to procedure.

ELECTRICAL

1. Will not trim up or out.	a. Limit switch open or disconnected. b. Defective push button or rocker switch. c. Defective trim motor solenoid. d. Proper switch not operated.	a. Replace switch or reconnect. b. Test, replace defective part(s). c. Replace solenoid d. Refer to Owner's Guide or Service Manual.
2. Will not tilt to full "Up" position.	a. Proper switch not operated. b. Low battery charge.	a. Refer to Owner's Guide or Service Manual. b. Charge battery.
3. Will trim up or out with drive unit in reverse gear.	a. Interlock switch shorted or will not open.	a. Replace switch.
4. Pump motor runs intermitently.	a. Open in armature b. Open or loose connections	a. Replace part. b. Test, replace defective part.
5. Pump motor runs only in down direction.	a. Improper wiring. b. Proper switch not operated. c. Interlock switch open or disconnected. d. Solenoid inoperative. e. High resistance or broken or loose connection in wiring, grounds or solenoid. f. Defective key, push button or rocker switch. g. Defective pump motor.	a. Trace and correct wiring. b. Refer to Owner's Guide or Service Manual. c. Replace switch or reconnect leads. d. Test, replace defective part(s). e. Test, replace defective part(s). f. Test, replace defective part(s). g. Test, replace defective part(s).

6. Pump motor runs only in "Up" direction.	a. Improper wiring. b. Proper switch not operated. c. High resistance or broken or loose connection in wiring, grounds or solenoid. d. Defective pump motor. e. Defective push button or rocker switch.	a. Trace and correct wiring. b. Refer to Owner's Guide or Service Manual. c. Test, replace defective part(s). d. Test, replace defective part(s). e. Test, replace defective part(s).
7. Pump motor does not run.	a. Low battery charge. b. Improper wiring. c. High resistance or broken or loose connection in wiring, grounds or solenoid. d. Defective pump motor. e. Defective key, push button or rocker switch. f. Motor overload switch open due to overheating.	a. Charge battery. b. Trace and correct wiring. c. Test, replace defective part(s). d. Test, replace defective part(s). e. Test, replace defective part(s). f. Allow pump to cool - avoid continuous operation.
8. Trims out or tilts up while unattended.	a. Moisture in key switch. b. Defective push button or rocker switch.	a. Replace part. b. Test, replace defective part.

HYDRAULIC

1. Will not trim up or out.	a. Oil level low. b. External leaks (fittings and parts leak). c. Internal cylinder leaks. d. Too low or no pump pressure. e. Reverse lock valve inoperative. f. Internal resistance in cylinders.	a. Add oil (Formula 4-20W) and bleed system. b. Tighten fittings or replace if defective. c. Repair or replace cylinder. d. Replace pump body assembly. e. Replace valve and/or adjust. f. Replace or repair cylinder(s).
2. Will not tilt to full "Up" position.	a. Internal resistance in cylinders. b. Oil level low.	a. Replace or repair cylinder(s). b. Add oil (Formula 4-20W) and bleed system.
3. Will not release from full "Up" position.	a. Internal resistance in cylinders. b. Too low or no pump pressure. c. Oil level low. d. Control valve assembly inoperative.	a. Replace or repair cylinder(s). b. Replace pump body assembly. c. Add oil (Formula 4-20W) and bleed system. d. Replace assembly.
4. Will not return completely to "Down" position or returns part way with jerky motion.	a. Internal resistance in cylinders. b. Too low or no pump pressure. c. Air in system. d. Hoses reversed on one cylinder only.	a. Replace or repair cylinder(s). b. Replace pump body assembly. c. Check for leaks and bleed system properly. d. Reinstall to proper connection.
5. Will not hold ih reverse.	a. External leaks (fittings and parts leak). b. Internal cylinder leaks. c. Dirt in system. d. Reverse lock valve inoperative.	a. Tighten fittings or replace if defective. b. Replace or repair cylinder. c. Flush system with clean oil, fill and bleed. d. Replace valve and/or adjust.
6. Out drive thumps when shifted.	a. Air in system. b. Internal cylinder leaks. c. Leak in control valve.	a. Check for leaks and bleed system properly. b. Replace or repair cylinder. c. Replace assembly.
7. Trails out when backing off throttle at high speed.	a. Internal cylinder leaks. b. Control valve assembly inoperative. c. Air in system.	a. Replace or repair cylinder. b. Replace assembly. c. Check for leaks and bleed system properly.
8. Will not hold a trimmed position or will not remain tilted for extended period.	a. External leaks (fittings or parts leak). b. Internal cylinder leaks. ● c. Pump check valve leak (high pressure). ● d. Dirt in system.	a. Tighten fittings or replace if defective. b. Replace or repair cylinder. c. Replace pump body assembly. d. Flush system with clean oil, fill and bleed.
9. Pumps up or out slowly with jerking movements when tilting or trimming.	a. Hoses reverse on one cylinder only.	a. Reinstall to proper connection.
10. Reverse lock valve broken open and leaking.	a. Control valve assembly inoperative. b. Reversed hose installation on control valve body or gimbal housing.	a. Replace assembly. b. Reinstall to proper connection.
11. Oil foams out of pump vent.	a. Oil level low. b. "Can" is not properly installed over filter screen.	a. Add oil (Formula 4-20W) and bleed system. b. Reinstall "Can" over oil filter screen.

● *Pump check valve may contain entrapped foreign particles which can be cleared by operating system up-and-down several times when flushing system. If flushing system fails to correct the problem, the check valve is defective.*

POWER TILT and TRIM

DESCRIPTION

Power Tilt or Power Trim hydraulic system consists of a combination of the following:
A tilt or trim cylinder, control valve, reverse lock valve, trim indicator, hydraulic pump (which consists of a valve body), gear assembly pump motor and reservoir and associated hoses and fittings. Troubleshooting, removal, repair and reassembly will be discussed in this part (Part "A").

TROUBLESHOOTING

If hydraulic system does not function properly, proceed as follows:

1. Be sure that drive unit is shifted into forward. (Shift interlock switch prevents Power Trim from operating in reverse.)
2. Determine if problem is electrical or hydraulic. Disconnect blue wire in "Up" circuit or green wire in "Down" circuit from pump motor harness and reconnect wire to positive terminal of battery. If pump motor runs, problem is in electrical circuit.
3. Check control panel switches and wiring harness for short or open circuit.
4. Check all hydraulic lines to be sure that they are properly connected and tightened.
5. Check pump reservoir. Level must be level with threads of fill hole.
6. Check cylinder with "Power Tilt Cylinder Check" or "Power Trim Cylinder Check", following.
7. Check reverse lock valve.
8. Test hydraulic pump.
9. Refer to "Troubleshooting Chart", preceding, and hydraulic trim up and trim down diagrams as an aid to troubleshooting. (Figures 1 and 2)

PRECAUTIONS

WARNING:

1. **Low pressure white pumps use SAE 10W30 4-cycle engine oil.**
2. **High pressure white pumps use type "A" suffix "A" transmission fluid.**
3. **Large reservoir high and low pressure black pumps use 20W MS rated oil.**

Observe the following when installing, servicing or testing Power Trim or Power Tilt Systems with large reservoir pump.

1. When installing hydraulic oil lines-
   Start threads with fingers so they will not cross-thread. DO NOT overtighten hydraulic line fittings, or threads will be stripped out of tilt cylinders or pump hoses. Fittings should be "snugged up" until no leaking occurs at the fitting.
2. Align pump valve body and gear assembly, tightening the 8 screws evenly to prevent pump motor shaft from binding.

NOTE: When performing repairs, use caution that up-and-down hydraulic hoses are not reversed. When operating Power Trim for the first time, push the down switch first. If drive unit rises, hydraulic hoses are reversed on valve housing assembly at pump base. Switch hoses to correct this condition. If these precautions are taken and cover breakage still occurs, it will be necessary to replace control valve body assembly on hydraulic pump. If "O" ring comes out of reverse lock valve, or if valve leaks, remove valve cover, install washer (C-12-59570) and a new "O" ring valve cover. Use Loctite 35 (C-92-59328) on screw threads when installing cam-to-cam lever screw. Reassemble and readjust valve.

3. Use clean, uncontaminated MS rated 20W oil to fill reservoir or when flushing hydraulic system.
4. Overfilling pump reservoir and failing to remove vent seal may damage "O" ring gaskets, thereby causing pump body or motor failure.
5. Drive unit must be in "down" position with hydraulic cylinders collapsed when filling reservoir. Oil level should be even with bottom of oil filler hole.
6. Allow pump motor to cool at least one minute if pump stops during excessive use. An internal thermal circuit breaker protects pump motor.
7. Any modification to hydraulic system or assemblies without proper authority in writing from Kiekhaefer Mercury will void the warranty.
   Warranty on hydraulic pumps will NOT be honored if -
   a. Threads are stripped out of pump housing.
   b. Contaminated oil, wrong oil or dirt is found in pump reservoir.
   c. Pump modifications result in malfunction.
8. Service notes
   a. Work area must be dirt and lint-free. Slightest amount of dirt may cause pump to malfunction.
   b. Precision fitting of valves and gears requires that valve body and gear cage assembly or control valve assembly be replaced as a unit.
   c. These hydraulic pumps have a small metal can set over inlet screen of valve body and gear assembly.

Be sure that can is secure over inlet screen.

d. Use Liquid Neoprene (C-92-25711 or C-92-58650) sparingly and do not allow it in valve body and gear assembly.
e. Hydraulic pump motors require moisture-proofing, particularly after repair. To moisture-proof, apply Liquid Neoprene around pump motor commutator plate edges, around motor frame (where it contacts reservoir) and where leads enter motor.

CAUTION: Use care in handling trim cylinders during removal and/or installation of stern drive units to prevent damage to hydraulic hoses. Rough treatment could weaken the hose by overstress and could also bend the metal tubing, thus resulting in hose separation or splitting. Bending of metal tubing will misposition the hose and cause stress to hose after installation. With stern drive in full left and right turns in both full up and down positions, inspect hoses for twists, kinks and severe bends at fitting ends. Reposition hoses where necessary for free operation without stress to hoses.

IDENTIFICATION of HYDRAULIC PUMPS

NOTE: The higher pressure applied to small diameter tilt cylinders will over-extend them and cause damage to stern drive and related components.

To determine whether a large reservoir pump is low pressure type, examine valve body and gear assembly on hydraulic pump. If pump is lower pressure type, letter "A" is stamped after No. 105255. If letter "A" does not appear after the number, pump is higher pressure type and must not be used as a replacement for small reservoir white pump.

IDENTIFICATION of TRIM and TILT CONTROL VALVES

MerCruiser tilt and trim control valves are similar in appearance.

1. Trim control valve has 2 tapped holes for hydraulic lines or one tapped hole and one 90° brass elbow.
2. Tilt control valve has one tapped hole and one hole which is not tapped.

Following control valve part numbers will aid in identification of similar control valves.

PART NO.	USED ON
B-45382A1	Tilt Systems
B-45764A2	1967 Trim Systems
B-48077A3	1968 and up MC 120 - 160
B-48077A4	MerCruiser III, 215H, 215E
B-48077A6	MerCruiser II

NOTE: Angle of elbow determines part number, horizontal, 45° or 90°.

HYDRAULIC PUMP - LOW PRESSURE TYPE

If low pressure pump will not function properly, replace entire low pressure hydraulic pump and booster with high pressure large reservoir pump conversion kit, following.

NOTE: Repair of low pressure hydraulic pump and electric motor is same as high pressure hydraulic pump electric motor.

REMOVING LOW PRESSURE PUMP

1. Disconnect blue and green pump motor leads from control panel terminal block.
2. Disconnect black pump motor lead from engine terminal block.
3. Disconnect red/white jumper lead from control panel terminal block and engine terminal block.

   NOTE: Some Power Tilt Pumps do not have red/white jumper lead. On this pump, disconnect red battery lead from battery and control panel terminal block. Disconnect black battery lead from battery or engine terminal block.

4. Slide knurled collar on hose connector down and remove connector from valve. (Figure 1)
5. Remove screws, "D" washers and clamps which fasten pump motor harness to boat.
6. Remove 3 nuts, which fasten pump to mounting bracket, and remove low pressure pump assembly and bracket from boat. (Figure 1)

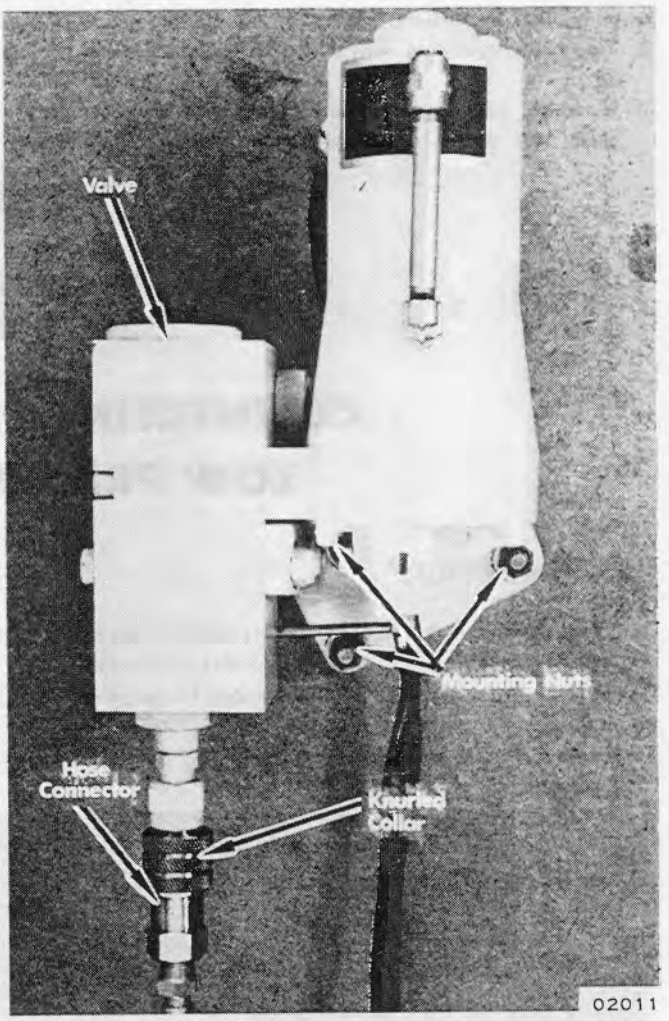


Figure 1. Low Pressure Pump Assembly

MOUNTING HIGH PRESSURE PUMP

1. Fasten pump and mounting bracket assembly to transom with 3 carriage bolts and nuts which were removed previously in Step No. 6. (Figure 1) Position vertivertically, as shown in Figure 2.
2. Remove vent screw and discard plastic gasket seal. Replace screw and tighten lightly. Vent must remain open during operation.
3. Pump unit has been filled with oil, however, check hydraulic system oil level as follows:
   a. Drive unit must be all the way down in normal operating position.
   b. Remove "Fill" screw.
   c. If oil level is low, fill reservoir to bottom of threads with type "A" suffix "A" transmission fluid. DO NOT over-fill.
   d. Replace "Fill" screw.

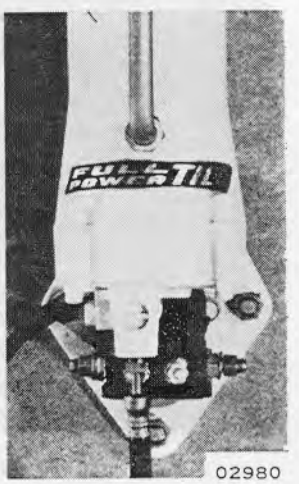


Figure 2. High Pressure Pump Assembly Mounted on Transom

CONNECTING HYDRAULIC HOSE

NOTE: Following instructions apply to all Power Tilt Systems, except those with low pressure white pump. Refer to instructions outlined under "Connecting Hydraulic Hoses - Low Pressure White Pump", which follows.

To prevent loss of oil, connect hose to pump as quickly as possible, as follows:

1. Remove fitting on end of hose from connector. (Figure 3)
2. Remove plug from base of pump and rapidly connect hose to pump. Tighten fitting securely. (Figure 4)

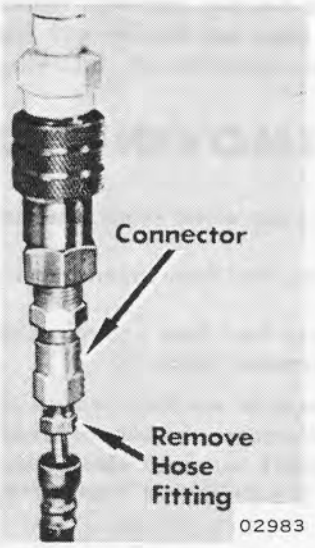


Figure 3. Hose Fitting and Connector

Figure 4. Hose Connected to Pump

CONNECTING HYDRAULIC HOSES - LOW PRESSURE WHITE PUMP

FULL POWER TILTS

NOTE: In order to connect hydraulic hoses to pump, hose assembly (B-32-36169A1) must be used.

To prevent loss of oil, connect hoses to pump as quickly as possible, as follows:

1. Remove fittings (located on ends of hydraulic hoses) from tee fitting. (Figure 5)

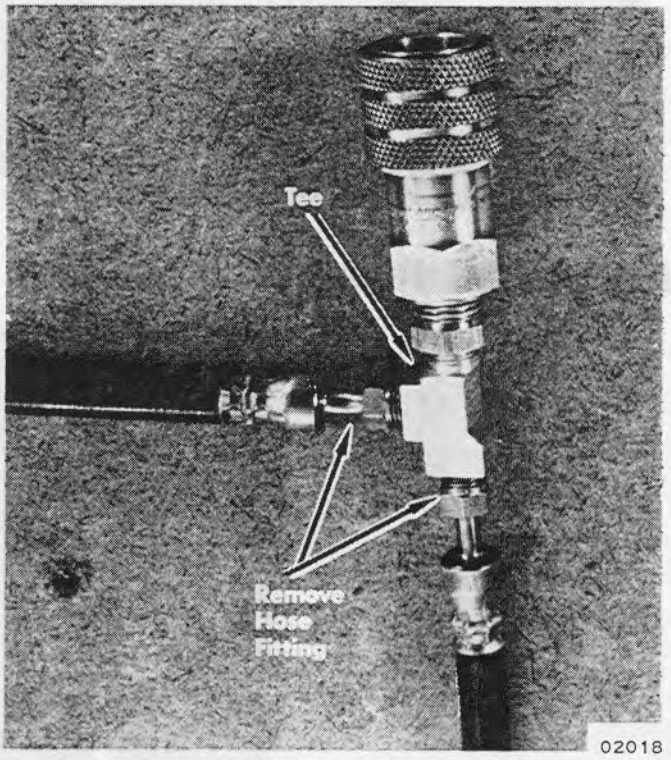


Figure 5. Hose Fittings

Figure 6. Hose Connected

2. Thread hose fittings into new tee fitting (supplied with hose assembly) and tighten securely. (Figure 6)
3. Thread fitting (located on one end of short hose) into tee fitting and tighten securely. (Figure 6)
4. Remove plug from pump base and thread fitting (located on end of short hose) into pump base. Tighten fitting securely. (Figure 6)
5. Fasten hoses to boat with clamps, "D" washers and screws. (Figure 6)

WIRING CONNECTIONS (Refer to Figure 7)

1. Plug harness adaptor onto receptacle of replacement hydraulic pump.
2. Connect leads from opposite end of harness adaptor control panel terminal block, matching color code as shown in Figure 7.
3. Connect black battery lead to negative (-) battery terminal.
4. Connect red battery lead to positive (+) battery terminal.

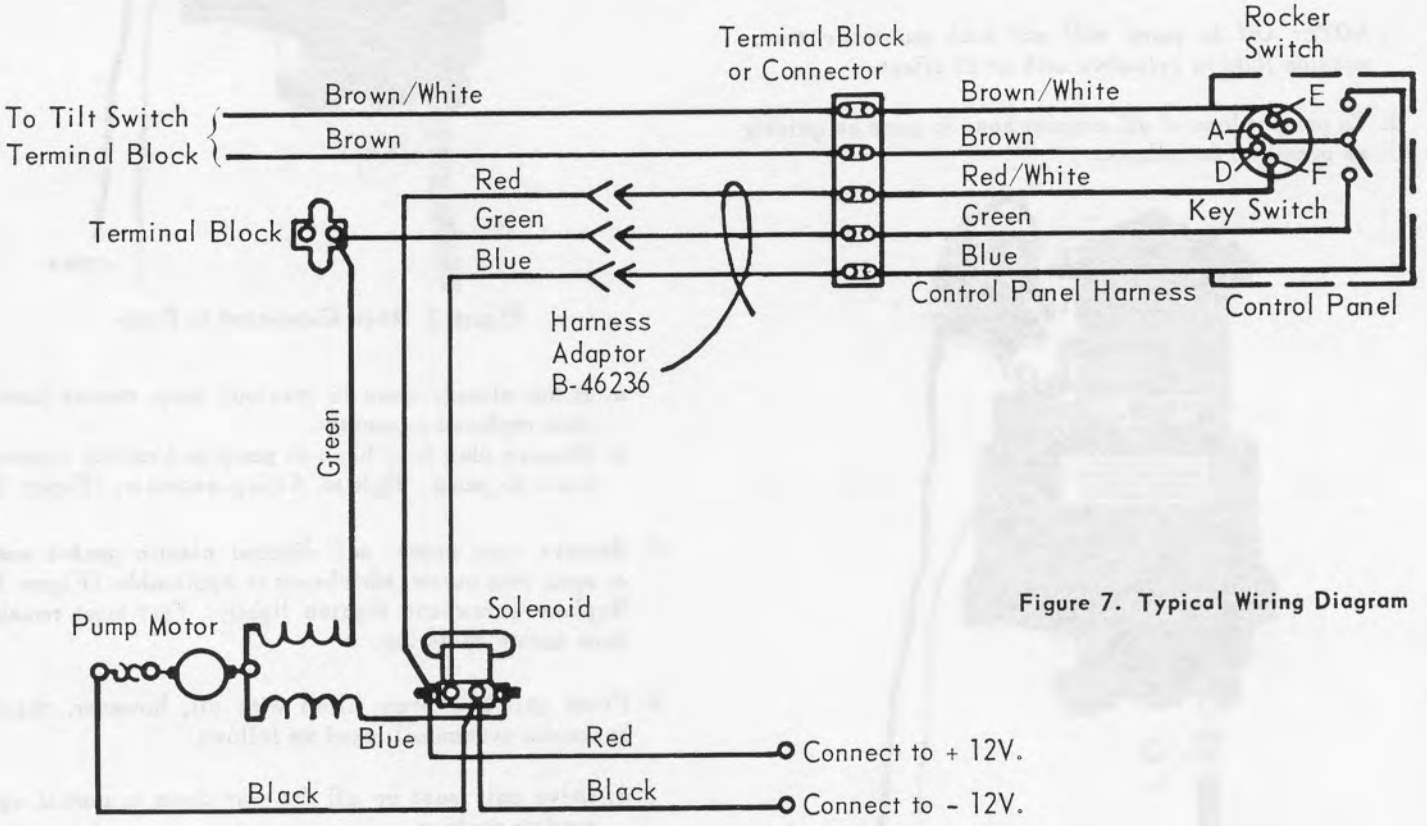


Figure 7. Typical Wiring Diagram

HYDRAULIC PUMP - HIGH PRESSURE TYPE

If high pressure pump will not function properly, replace entire high pressure hydraulic pump with high pressure large reservoir pump conversion kit.

REMOVING REPLACED PUMP

1. Disconnect large red and black battery wires from battery to prevent possibility of a short.
2. Remove large red and black battery wires and small red, blue and green wires from pump and solenoid.
3. Remove nuts from 3 mounting bolts and remove pump assembly and mounting bracket (if applicable).
4. Do not remove hydraulic hose from pump at this time. If it is necessary to remove hose, use caution to prevent loss of oil.

MOUNTING LARGE RESERVOIR PUMP

NOTE: If replaced pump was mounted on a mounting bracket on the transom, use new mounting bracket (supplied with kit). Install pump to bracket with 3 screws, washers and nuts (supplied with kit). If mounted directly to inner transom plate, discard mounting bracket.

1. Fasten pump and mounting bracket assembly to transom with 3 carriage bolts and nuts (removed previously) (Figure 1) or install pump directly to inner transom plate, whichever is applicable. Pump must be positioned vertically as shown in Figure 1.

   NOTE: Oil in pump will mix with automatic transmission fluid in cylinders with no ill effect.

2. To prevent loss of oil, connect hose to pump as quickly as possible, as follows:

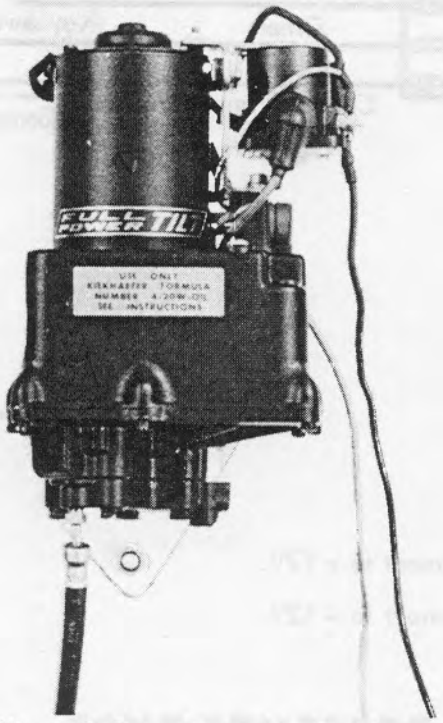


Figure 1. Pump Mounted in Position

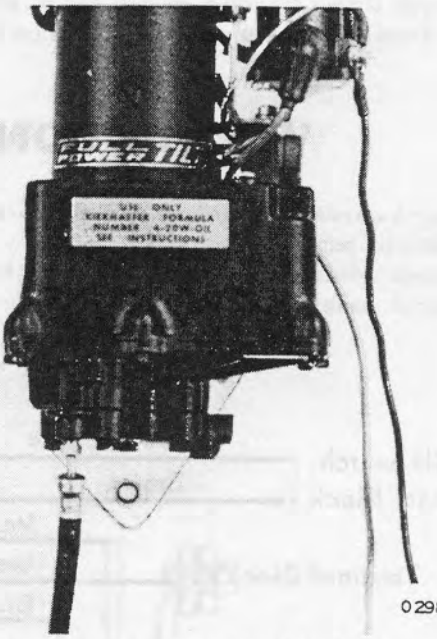


Figure 2. Hose Connected to Pump

   a. If not already done in previous step, remove hose from replaced assembly.
   b. Remove plug from base of pump and rapidly connect hose to pump. Tighten fitting securely. (Figure 2)

3. Remove vent screw and discard plastic gasket seal or open vent screw, whichever is applicable. (Figure 1) Replace screw and tighten lightly. Vent must remain open during operation.

4. Pump unit has been filled with oil, however, check hydraulic system oil level as follows:

   a. Drive unit must be all the way down in normal operating position.
   b. Remove "Fill" screw.
   c. If oil level is low, fill reservoir to bottom of threads with MS rated 20W oil. DO NOT over-fill.
   d. Replace "Fill" screw.

WIRING CONNECTIONS (Figure 3)

1. Plug harness adaptor onto receptacle of hydraulic pump.
2. Connect wires from opposite end of harness adaptor to harness with 10-32 screws and nuts, matching color-to-color. Slide rubber sleeves over connections to prevent shorting.
3. Place boot over large red battery wire and connect wire to solenoid. (Figures 1 and 3). Connect opposite end of red wire to positive (+) battery terminal.
4. Connect large black wire to solenoid. (Figures 1 and 3) Connect opposite end of black wire to negative (-) battery terminal.
5. This completes hydraulic pump replacement.

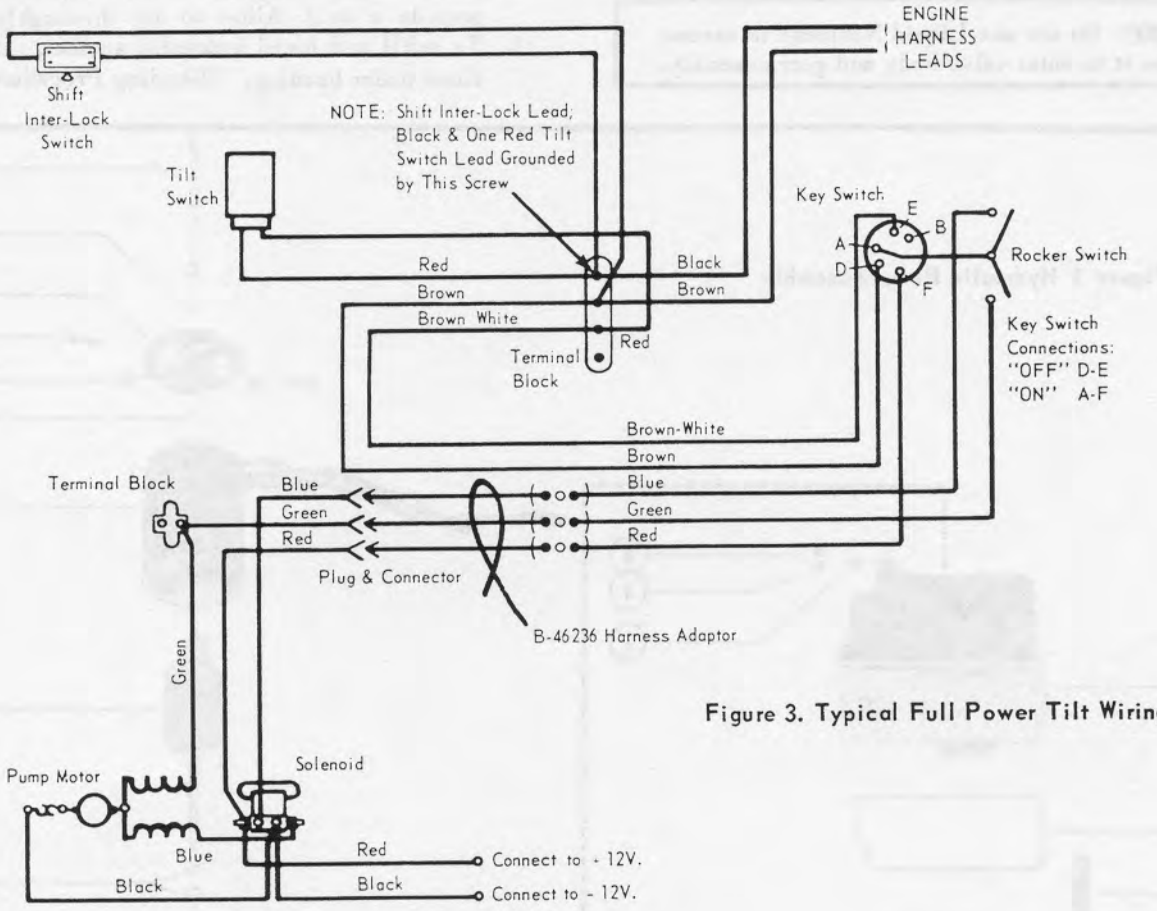


Figure 3. Typical Full Power Tilt Wiring Diagram

LARGE RESERVOIR HYDRAULIC PUMP - HIGH PRESSURE

REMOVAL and INSTALLATION

1. Remove hydraulic hoses and electrical wiring from pump. Mark wires and hoses for ease in reassembly.
2. Remove mounting bracket bolts and remove pump.

DISASSEMBLY

CAUTION: Work area must be dirt-and-lint-free, since slightest amount of dirt in hydraulic system will cause pump malfunction.

1. Remove fill screw and drain oil.
2. Remove four 7/16" screws from control valve assembly.
3. Remove 8 flat head screws from valve body and gear assembly.
4. Separate reservoir from valve body. (Figure 1)

NOTE: Precision fitting of valves and gears require that valve body and gear cage assembly must be replaced as a unit.

These hydraulic pumps have a small can set over inlet screen of valve body and gear assembly. Place can over inlet screen when reassembled.

REASSEMBLY

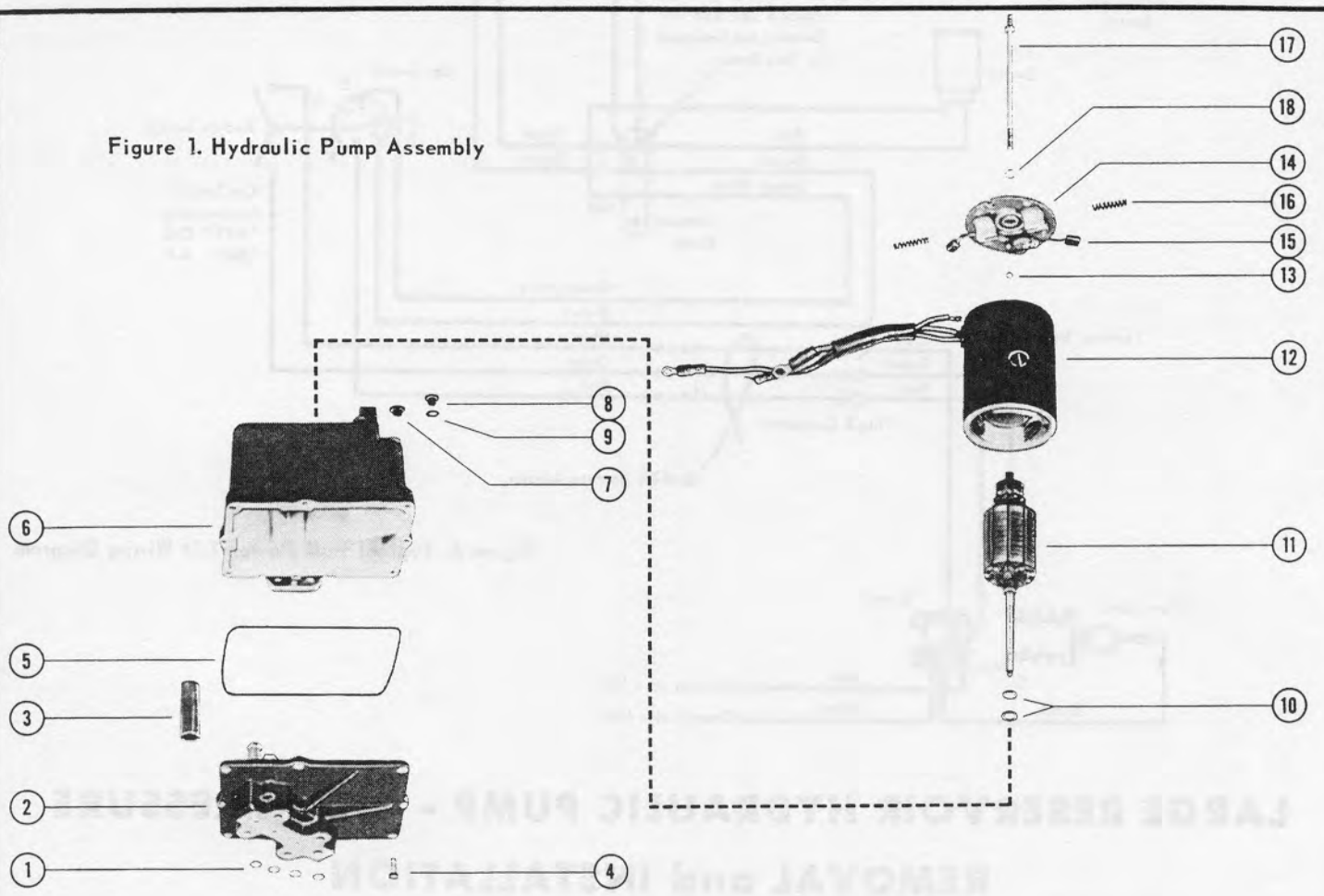
CAUTION: Work area must be dust-and-lint-free. Slightest amount of dirt will cause pump to malfunction.

1. Place small amount of Liquid Neoprene (C-92-25711-1) in seal groove of valve body and gear assembly to hold seal in place during installation.

CAUTION: Do not use Liquid Neoprene in excess or allow it to enter valve body and gear assembly.

2. Replace seal on valve body and gear case assembly.
3. Install valve body and gear cage assembly to reservoi with 8 flat head screws, tightening evenly.
4. Place new "O" rings on manifold and install control valve to valve body and gear cage assembly with four 7/16" bolts, tightening evenly.
5. Place Liquid Neoprene around edges of housings to provide a seal. Allow to dry thoroughly and repaint.
6. To refill and bleed hydraulic system, refer to instructions under heading, "Bleeding Procedure", following.

Figure 1. Hydraulic Pump Assembly



1	"O" Ring, hydraulic pump	10	Washer, thrust - armature
2	Valve Body and Gear Assembly	11	Armature, field and frame
3	Can, valve body	12	Field and Frame Assembly
4	Screw, valve body to reservoir	13	Ball, commutator end plate
5	Seal, reservoir to valve body and gear	14	Plate Assembly, commutator end
6	Reservoir Assembly	15	Brush Set, commutator end plate
7	Screw, vent - hydraulic pump	16	Spring Set, brush tension
8	Screw, filler - hydraulic pump	17	Bolt Set, thru - plate and frame to reservoir
9	Washer, sealing - filler screw	18	Lockwasher, thru bolt

(Legend for Figure 1)

TESTING

Use Hydraulic Pump Test Gauge (C-91-52915A2).

HYDRAULIC PUMPS without CONTROL VALVES

NOTE: This is only test for pump, and it should be used first if pump is suspected as source of a problem as indicated by Power Tilt troubleshooting charts. For proper readings, battery must be fully charged and in good condition.

1. Install Test Adaptor Plate (C-91-52913A1) to pump with 4 new "O" rings, etc.
2. Connect hoses Nos. 1 and 2 as shown in Figure 3.
3. Connect an ammeter to motor leads for each test, as shown in Figure 4.
4. Fill pump reservoir with MS rated 20W oil.
5. Test for proper "Up" pressure and amperage as follows:
   a. Close valve No. 2 and open No. 1.
   b. Run pump in "Up" direction until pressure stops rising, as indicated on gauge.
   c. Read maximum pump output "Up" pressure and amperage. Pump pressure should be 3000 PSI minimum for new pumps (2700-3000 PSI for various pumps with some operational time or 1800-2600 PSI for Power Tilt pumps with "105255A" stamped on its base). Amperage reading must not exceed 100 amps.
   d. Stop pumping up. Gauge pressure will drop slightly, then hold steady. After stabilizing, pressure must not drop more than 100 PSI every 15 sec. High leakage rates indicate a poor or failed check valve in pump.
   e. Release built-up pressure by running pump "Down". If pressure fails to release, or if drive unit is failing to release from full "Up" position, then use Step 6, to check pump "Down" pressure.
6. Test for proper "Down" pressure and amperage as follows:
   a. Close No. 1 and open No. 2 valve.
   b. Run pump in "Down" direction until pressure stops rising. With pump running, read gauge "Down" pressure and amperage. Pressure must be 650 PSI minimum and may read as high as 1000 PSI.

NOTE: Early models may read as low as 550-650. Unit may fail to release from full up if using pump with less than 550 PSI "Down" pressure. Amperage should not exceed 400 amps. For proper readings, battery should be in good condition and fully charged.

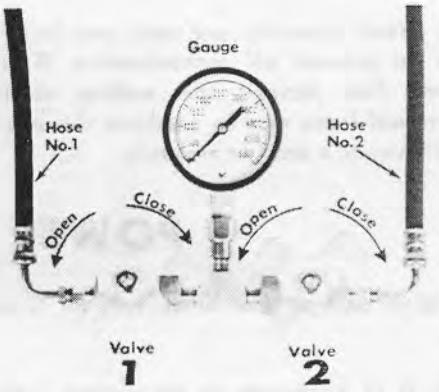


Figure 2. Gauge and Valve Assembly

MERCRUISER POWER TRIM HYDRAULIC PUMP WITH CONTROL VALVE

NOTE: DO NOT remove control valve from pump for test.

1. Perform Steps 1-thru-6 of "Hydraulic Pumps without Control Valves" test, preceding.
2. Control valve test
   a. Open valves Nos. 1 and 2.
   b. Run pump in "Up" direction and note gauge reading. This is "trail-out" relief pressure and should be 650-750 PSI. (Early models may read as low as 550-650 PSI.) Stop pumping "Up".
   c. Gauge reading should stabilize between 100-400 PSI or continue to drop slowly to zero.

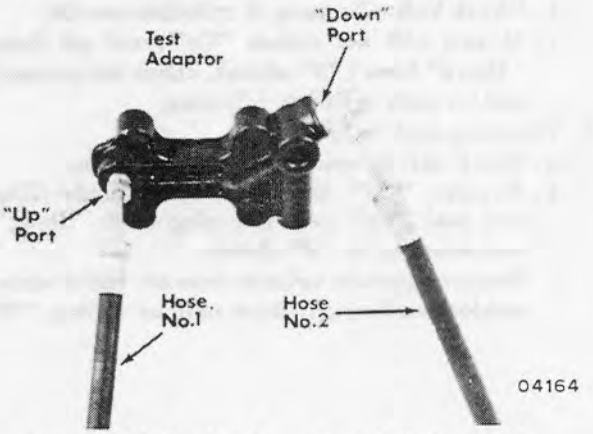
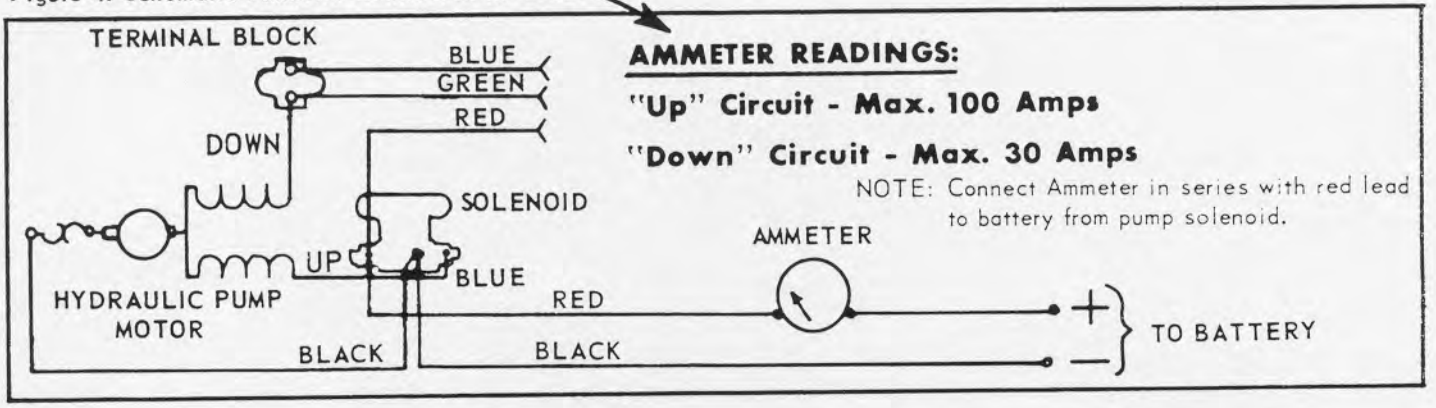


Figure 3. Hydraulic Pump Test Adaptor Plate

Figure 4. Schematic Ammeter Connected in Series



CYLINDER CHECKS

NOTE: Clean assembly and work area before removing fittings to prevent oil contamination. Wipe hydraulic oil away from fittings after making connections so that external leaks may be detected. Even a very slight leak will cause a drop in pressure.

WARNING: DO NOT paint sliding portion of Power Tilt or Power Trim cylinders. Because of precision fit between stainless steel piston and cylinder, paint will render lift cylinders inoperative.

POWER TILT CYLINDER CHECK

1. Tilt drive unit up and block unit so it cannot come down.

NOTE: It is necessary to disconnect cylinder, which is not being tested, from its aft mounting bolt.

2. Carefully remove hose from cylinder and close port with plug. Be sure that plug is tight.
3. Remove block from beneath drive unit. If unit creeps down, cylinder is defective.
4. Repeat preceding steps on opposite cylinder.

POWER TRIM CYLINDER CHECK

1. Pump unit up and block in nearly full "Up" position.
2. Disconnect "Up" hose from hydraulic pump and cap hose with cap or plug.

NOTE: Pump base has 2 lines. DO NOT disconnect hose from pump to reverse lock valve.

3. Disconnect "Down" hose from reverse lock valve (hose from reverse lock valve to drive unit) and tie up for observation.
4. Unblock and weight drive unit with 100 to 200 lbs. (45 to 90kg).
   a. If unit remains up, cylinders are OK.
   b. Check hydraulic pump if cylinders are OK.
   c. If unit will not remain "Up", and oil flows from "Down" hose ("3" above), check for external leaks and/or each cylinder, following.
5. Checking each cylinder
   a. Block unit in nearly full "Up" position.
   b. Remove "Up" hose from one cylinder (Figure 5) and seal "Up" port with plug (with "Down" hose connected as in "3" above).
   c. Remove opposite cylinder from aft end of drive, then unblock and weight drive unit as in Step "3", preceding. Cylinder is OK if unit remains up. Replace if faulty.
   d. Remove plug in "Up" port and reinstall hose to cylinder.
   e. Repeat steps "a" thru "d", immediately preceding, on second cylinder.

NOTE: Remove aft anchor pin when "Up" cylinder and "Down" cylinder check are performed on boat.

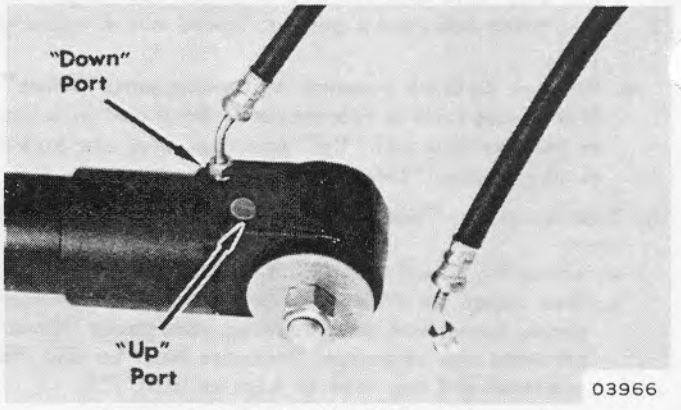


Figure 5. Cylinder "Up" Port Plugged

"DOWN" CYLINDER CHECK

NOTE: Use hydraulic pump (C-91-52915A1) when trim cylinders fail to hold drive in "Reverse" and/or prevent unit from returning to a full "Down" position, proceed as follows:

1. Install test gauge in "Down" circuit with both valves ("A" and "B") open. (Figure 6)
2. Operate trim "Down" or "In" to full cylinder retraction and check for external leaks.
   NOTE: Failure of cylinder to retract (with gauge reading 600-1000 PSI (42-70kg/sq. cm.) indicates a defect.
3. While operating trim "Down" or "In", close valve "A" and stop pump. Read gauge pressure. Pressure should remain steady at 550-850 PSI (39-60kg/sq. cm.). If pressure drops after closing valve, cylinder is defective.
   NOTE: If pump pressure does not rise above 550 PSI, check pump or pump control valve.
4. Remove test gauge and reinstall original lines. Keep hydraulic and gauge assemblies clean.
5. Repeat above procedure on other cylinder.

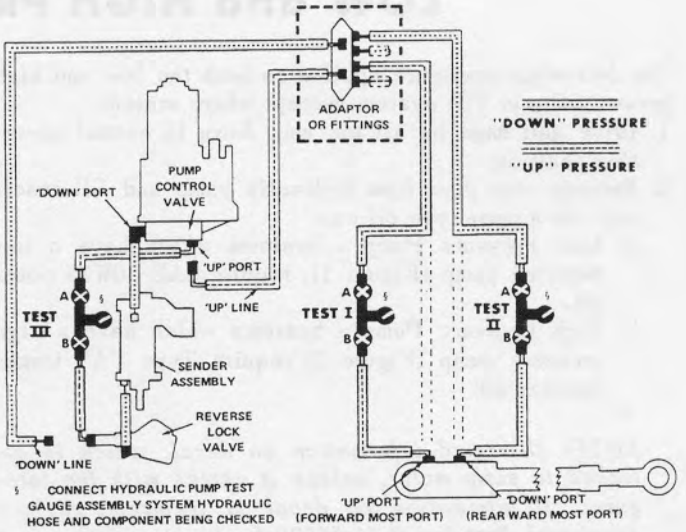


Figure 6. Hydraulic Circuits

"UP" CYLINDER CHECK

NOTE: Use Hydraulic Pump Test Gauge (C-91-52915A2) and check when trim cylinders hold drive in "Trim" or "Up". Purge air from lines before making connections.

1. Install test gauge in "Up" circuit with both valves ("A" and "B") open. (Figure 6)
2. Operate trim "Up" or "Out" to full cylinder extension and check for external leaks.
3. Read gauge pressure. Pressure should remain steady - approximately 2500-3500 PSI (162-232kg/sq. cm.)
   NOTE: If pressure is less than 2500 PSI, check pump.
4. Close valve "A" and stop pump. Line pressure should remain steady. If pressure drops, cylinder is defective.
5. Remove test gauge and reinstall original lines. Keep hydraulic and gauge assemblies clean!
6. Repeat above procedure on other cylinder.

BLEEDING PROCEDURE

LOW and HIGH PRESSURE WHITE PUMPS

The following procedure applies to both the low and high pressure Power Tilt system, except where stated:

1. Drive unit must be all the way down in normal operating position.
2. Remove vent pipe from hydraulic pump and fill reservoir via a pump type oil can.
   a. Low Pressure Pump - Systems which have a low pressure pump (Figure 1), require SAE 10W30 motor oil.
   b. High Pressure Pump - Systems which have a high pressure pump (Figure 2) require Type "A" transmission oil.

NOTE: Disregard information on decal, which is attached to pump motor, unless it agrees with the foregoing. If information on decal is incorrect, replace decal with Part No. B-37-35520 for low pressure pumps and B-37-37613 for high pressure pumps.

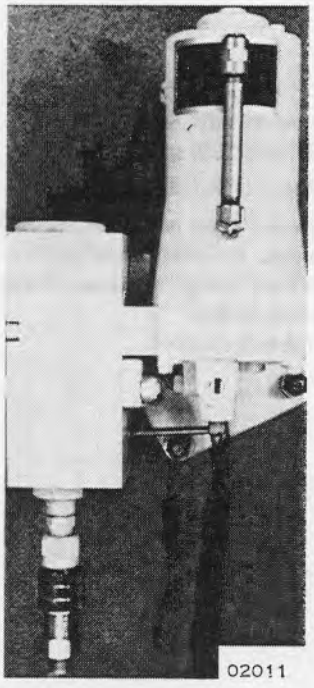


Figure 1. Low Pressure Pump

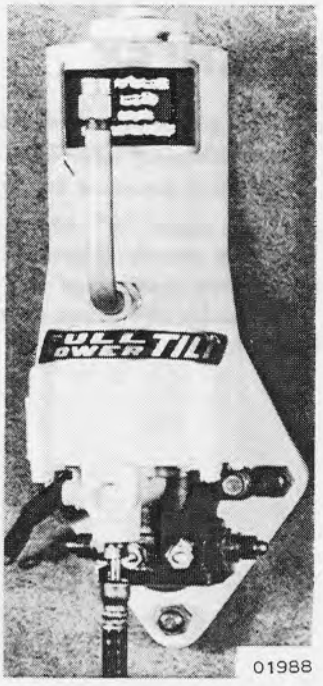


Figure 2. High Pressure Pump

3. Place reverse lock hook release lever in the release (down) position.
4. Place remote control handle in neutral or forward gear position.
5. Turn control panel key switch to "On" position and depress top of rocker switch. Hold rocker switch in until drive unit reaches end of its upward travel and stops.
6. For bleeding tilt cylinders with air bleed hole in lower aft portion of cylinder (Figure 3), proceed with one tilt cylinder at a time as follows:
   a. Place wrench on flats which are located on outer portion of one lift cylinder.

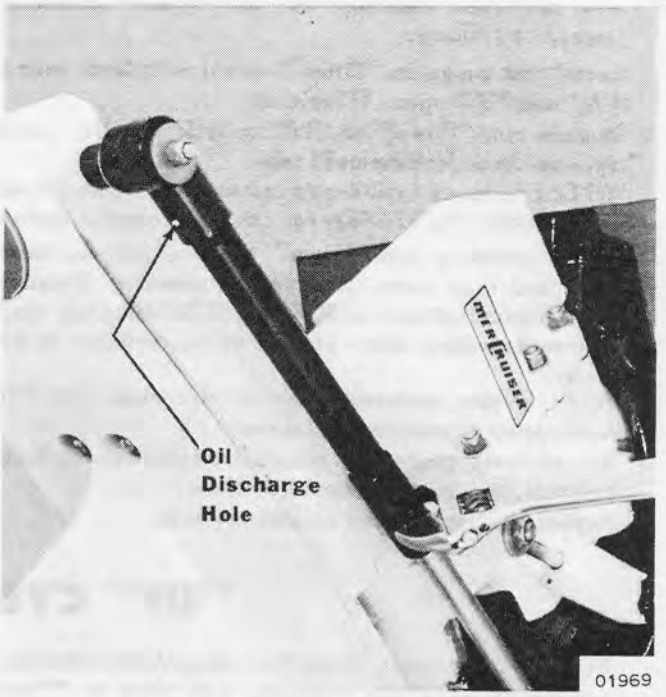


Figure 3. Bleeding Air from Hydraulic System - Early Style

   b. Turn outer portion of cylinder clockwise, when looking forward, until oil comes out of hole at lower aft end of tilt cylinder.
   c. Allow oil to drain out of cylinder until drive unit has traveled all the way down and stops.
   d. Turn outer portion of cylinder counterclockwise until it is tight.
7. For tilt cylinders with air bleed cover screw located at upper aft end of tilt cylinder (Figure 4), proceed as follows:
   a. Loosen screw on top of aft end of tilt cylinder. Early screw must be removed completely. Later tilt cylinders have a screw which is undercut and need only be turned out as far as the undercut.

Figure 4. Bleeding Air from Hydraulic System - Screw Vent

b. Place wrench on flats which are located on outer portion of tilt cylinder.
c. Turn outer portion of cylinder clockwise when looking forward, until oil comes out of screw hole at upper aft end of tilt cylinder.
d. Allow oil to drain out of cylinder until drive unit has traveled all the way down and stops.
e. Turn outer portion of cylinder counterclockwise until it is tight, then tighten screw.

8. Fill pump with oil again.
9. Turn control panel key switch to "On" position and depress top of rocker switch. Hold rocker switch in until drive unit reaches the end of its upward travel and stops.
10. Check cylinder, which was just bled, for oil leaks at aft end. Additional tightening of outer portion of cylinder may be required.
11. Repeat Steps 6 or 7 (as applicable), 8, 9 and 10 on other cylinder.
12. Install vent pipe in hydraulic pump. Face vent pipe down. Place a container directly under hydraulic pump to catch excess oil.
13. Turn control panel key switch to "On" position and depress bottom of rocker switch. Hold rocker switch in until drive unit reaches the end of its downward travel.
14. Repeat the complete bleeding procedure as many times as necessary to rid hydraulic system of all air bubbles.
15. Tighten vent pipe into hydraulic pump in the upright position and check system for leaks.
16. Return reverse lock hook release lever to the locked (up) position, if applicable.

NOTE: If the pump continues to "foam" from the vent pipe, or if air cannot be bled from the hydraulic system, it will be necessary to replace or repair the hydraulic pump.

BLEEDING PROCEDURE - LARGE RESERVOIR BLACK PUMP

On units equipped with Power Tilt or Power Trim, check the hydraulic system oil level periodically as follows:
1. Drive unit must be all the way down in normal operating position.
2. Remove "Fill" screw. (Figure 5)

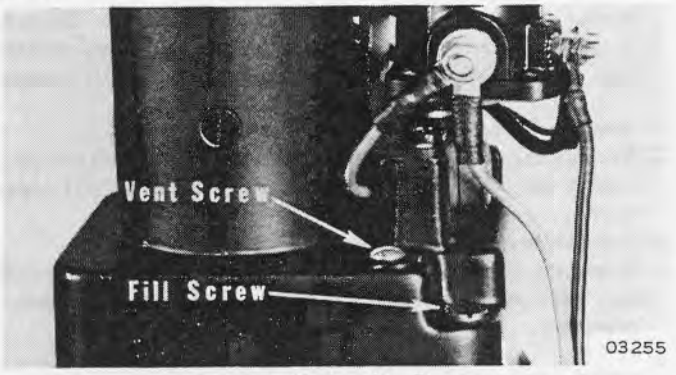


Figure 5. Hydraulic Pump

3. If oil level is low, fill pump to bottom of threads with SAE 20W "MS" oil. Do not over-fill.
4. Replace "Fill" screw.

Under normal conditions. Power Tilt and Power Trim units are self-bleeding; however, in event of partial or complete loss of fluid, the system, necessarily, must be purged of air. Use the following bleeding procedure:

NOTE: Keep pump reservoir filled at all times with SAE 20W "MS" oil.

POWER TILT CYLINDER BLEEDING PROCEDURE

1. With drive unit all the way down in normal operating position, disconnect cylinders from aft anchor pin and lower aft end of cylinders until both are in a near vertical position.
2. While maintaining the pump reservoir at capacity with (20W) oil, run hydraulic pump "up" until both cylinders are fully extended. (Figure 7)
3. Disconnect one hydraulic hose from its cylinder and slowly retract cylinder by hand while maintaining vertical position until excess air and oil is expelled and cylinder bottoms out. (Figure 6)

NOTE: MerCruiser 80-90 cylinders on some models will retract themselves by an internal spring.

Figure 6. Cylinder Disconnected

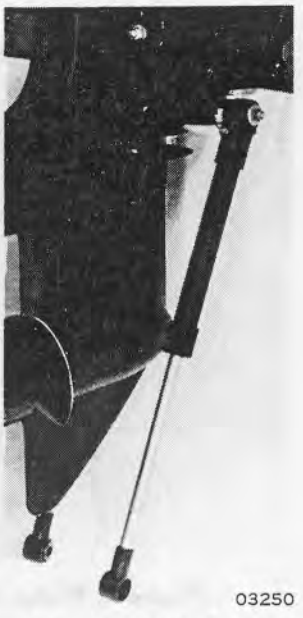


Figure 7. Cylinder Extended

4. Run pump in "up" direction for a second or two to purge air from the hydraulic hose and reconnect hose to cylinder.
5. Repeat Steps 3 and 4 on other cylinder.
6. Reconnect cylinders to aft anchor pin.

POWER TRIM CYLINDER BLEEDING PROCEDURE

BLEEDING "DOWN" SIDE of CYLINDER

1. With drive unit all the way down in normal operating position, disconnect aft end of cylinders from drive shaft housing and remove rear mounting pin.

2. Loop a length of rope thru lifting eye in top cover of drive shaft housing and tie each cylinder to hold in a horizontal position. (Figure 8)

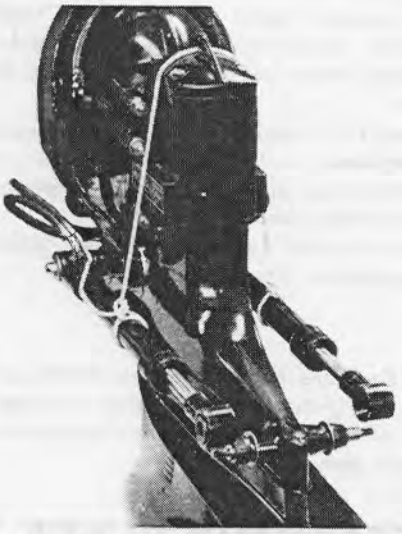


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Figure 8. Cylinder Tied in Horizontal Position

3. Run hydraulic pump in "down" position until both piston rods are fully retracted. Check oil level of pump to be certain that it is full.
4. Disconnect aft hose on one cylinder and run pump in "up" direction. This will extend the piston rod and purge oil and air from the cylinder. (Figure 9)

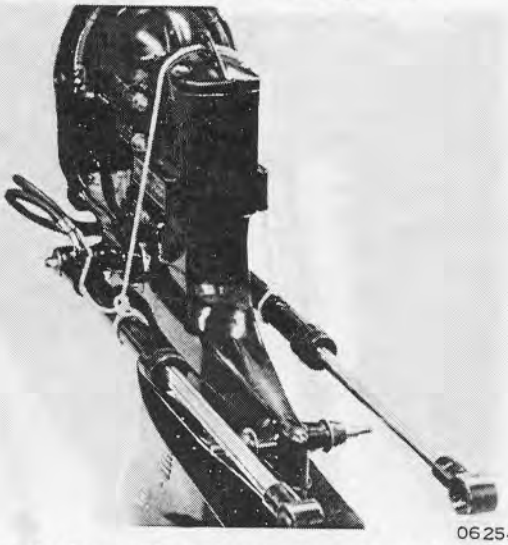

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Figure 9. Piston Rod of Cylinder Extended

5. Run pump in the "down" direction for a moment to purge any air in hose line to cylinder. When free of air, connect hose back to cylinder.
6. Repeat Steps "4" and "5" for the other cylinder.
7. Bleed "up" side of cylinder, following.

DO NOT overtighten hydraulic line fittings, or threads will be stripped out of tilt cylinders or pump hoses. Fittings should be "snugged up" until no leaking occurs at the fitting.

BLEEDING "UP" SIDE of CYLINDER (Following Bleeding "Down" Side of Cylinder)

1. Remove rope and allow cylinders to hang in near vertical position.
2. Run hydraulic pump in "up" direction until piston rods are fully extended.
3. Disconnect front hose on one cylinder and run pump in "down" direction. This will retract the piston and purge air and oil from the cylinder.
4. Run pump in "up" direction for a moment to purge any air in hose line to cylinder. When free of air, connect hose to cylinder.
5. Repeat Steps 4 and 5 for the other cylinder.
6. Reinstall cylinders to aft anchor pin.

ALTERNATE METHOD of BLEEDING AIR from CYLINDERS

1. Fill pump reservoir to proper level with cylinders retracted.
2. Remove cylinders from drive, then allow cylinders to hang down. This may be done with the boat in the water.
3. Operate the Power Trim system several times, extending and retracting the cylinders.
4. Position cylinders horizontially over drive anchor pin.
5. Operate the Power Trim system several times, extending and retracting the cylinders.
6. Reinstall cylinders. If air in cylinders is still apparent, bleeding procedure, preceding, must be followed.

BLEEDING PROCEDURE with TRIM INDICATOR ACCESSORY on MERCRUISER 120-165 and III DRIVES ONLY

NOTE: Air, that may have entered hydraulic system during indicator installation, will become trapped in the sender. The following "Bleeding Procedure" will not require bleeding the system at the cylinders.

1. Remove bleed screw "B". (Figure 10)
2. Momentarily press the "Down" or "In" button and repeat until oil flow is free of air, then reinstall bleed screw.
3. Remove bleed screw "A". (Figure 10)
4. Momentarily press "Up" button until oil flow is free of air, then reinstall bleed screw and add oil to pump reservoir.

NOTE: Be cautious not to lose "O" ring seals when removing bleed screws.

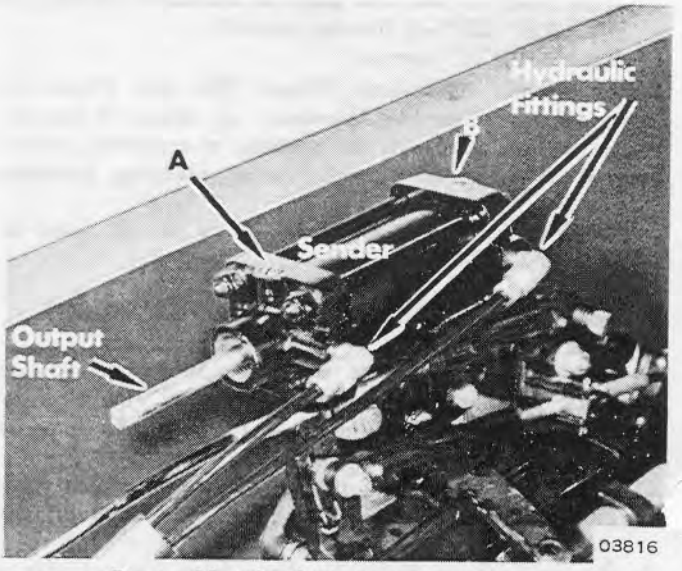

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Figure 10. Bleed Screw Locations

NOTE: If air cannot be bled from cylinder, refer to "Cylinder Checks", preceding.

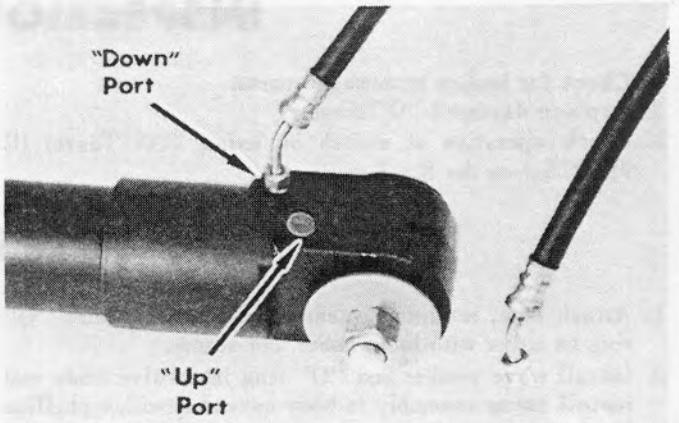


Figure 11. Cylinder "Up" Port Plugged

REVERSE LOCK VALVE

REMOVAL

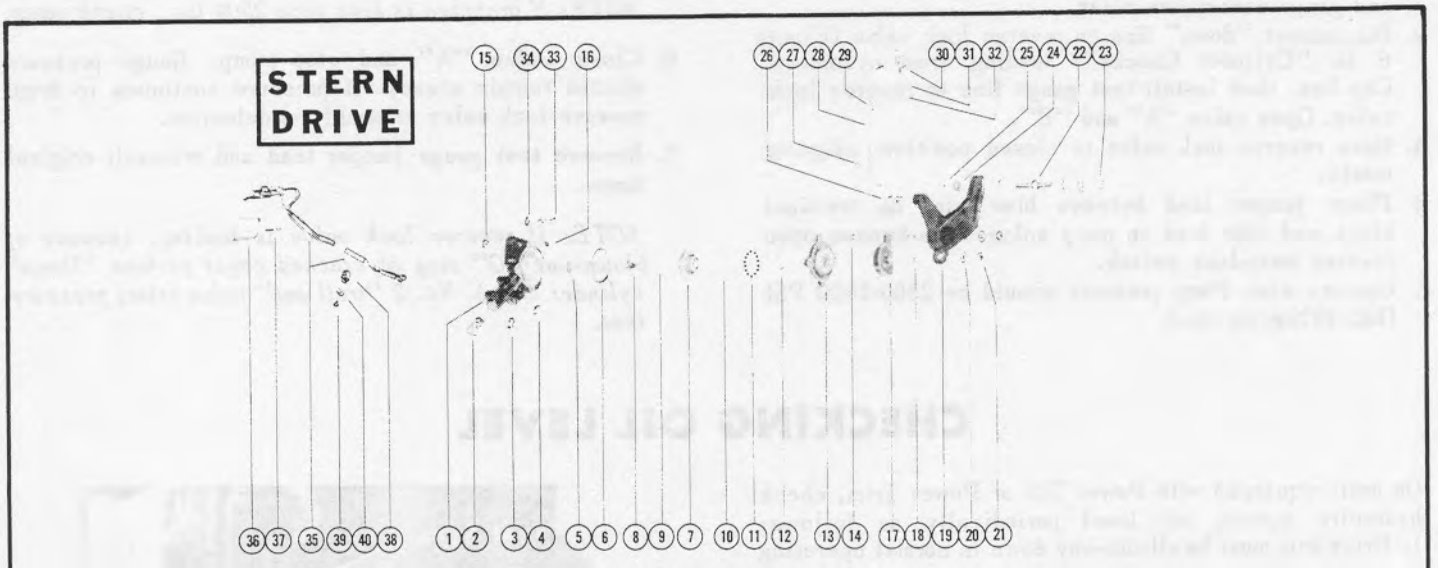
1. Disconnect 2 hydraulic lines.
2. Loosen 2 hex head screws on switch and remove electrical leads from switch.
3. Remove 2 nuts and remove cam assembly.
4. Remove 2 screws and remove reverse lock valve.

DISASSEMBLY (Figure 1)

1. Remove 4 phillips head screws and remove cover and cam assembly.
2. Remove cam to cam lever screw.

CAUTION: Do not lose ball bearings.

3. Remove "O" ring and wave washer.



1	Reverse Lock Valve Body	11	Ball, valve cover	21	Nut	31	Washer, link rod swivel
2	Elbow	12	"O" Ring, valve cover	22	Stud	32	Nut, link rod swivel
3	Connector, elbow	13	Cover, reverse lock valve	23	Nut, shift cable stud	33	Screw
4	Follower, cam	14	Screw	24	Washer, shift cable stud	34	Lockwasher
5	Washer, wave	15	Nut, cover screw	25	Nut	35	Switch Assembly, cut-out
6	"O" Ring	16	Plug, pipe	26	Swivel, link rod to shift lever	36	Shield, cut-out switch
7	Cam, reverse lock valve	17	Lever Assembly, cam	27	Link Rod Assembly	37	Screw
8	Screw, cam to cam lever	18	Stud	28	Nut, jam - link rod	38	Clip
9	Lockwasher, cam screw	19	Lever, shift - cam lever	29	Link Rod, shift lever	39	Screw
10	Washer, retaining	20	Washer, cam lever stud	30	Swivel	40	"D" Washer

Figure 1. Exploded View - Reverse Lock Valve

INSPECTION and CHECKS

1. Check for broken or damaged parts.
2. Replace damaged "O" rings.
3. Check operation of switch by using VOA Tester (C-91-52751) on the R x 1 scale.
4. Attach test lead to each switch lead.
5. Operate switch. VOA test should read infinite an zero ohms as switch is operated.

REASSEMBLE

1. Attach cam, retaining washer, ball bearings and "O" ring to cover with lockwasher and screw.
2. Install wave washer and "O" ring into valve body and install cover assembly to body assembly with 4 phillips head screws.
3. Install valve assembly to engine.

NOTE: If reverse lock valve leaks, or "O" ring comes out of valve, replace valve assembly.

REVERSE LOCK ADJUSTMENT

Refer to "MerCruiser Removal, Installation and Alignment", Section 2.

"REVERSE" LOCK VALVE LEAK CHECK (Using Hydraulic Pump Test Gauge C-91-52915A2)

NOTE: "Reverse" lock valve internal leak check (trim cylinders OK) when drive unit will not hold reverse thrust.

1. Disconnect "up" line from hydraulic pump. Cap line, then install test gauge line into "up" circuit. (Figure 6 in "Cylinder Checks", preceding) Keep hydraulic and gauge assemblies clean.
2. Disconnect "down" line on reverse lock valve (Figure 6 in "Cylinder Checks") leading from cylinders. Cap line, then install test gauge line to reverse lock valve. Open valve "A" and "B".
3. Move reverse lock valve to closed position, aligning marks.
4. Place jumper lead between blue wire on terminal block and blue lead on pump solenoid to bypass open reverse inter-lock switch.
5. Operate trim. Pump pressure should be 2500-3500 PSI (162-232kg/sq. cm.).

CAUTION: Never bypass reverse inter-lock switch. If switch is bypassed, and pump is run in "Up" direction, boosting action of cylinders will build hydraulic pressures which will burst the cylinders and/or hydraulic lines.

NOTE: If pressure is less than 2500 lbs., check pump.

6. Close valve "A" and stop pump. Gauge pressure should remain steady. If pressure continues to drop, reverse lock valve assembly is defective.
7. Remove test gauge jumper lead and reinstall original lines.

NOTE: If reverse lock valve is leaking, because of blown-out "O" ring or cracked cover perform "Down" cylinder check, No. 2 "trail out" valve relief pressure test.

CHECKING OIL LEVEL

On units equipped with Power Tilt or Power Trim, check hydraulic system oil level periodically as follows:

1. Drive unit must be all-the-way down in normal operating position.
2. Remove "Fill" screw. (Figure 2)
3. If oil level is low, fill pump to bottom of threads with MS rated 20W oil. Do not over-fill.
4. Replace "Fill" screw.

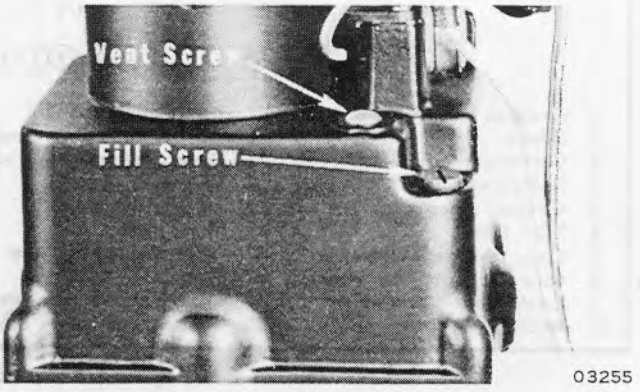


Figure 2. Hydraulic Pump

PUMP MOTOR

DESCRIPTION

Two different pump motors are used for all Power Tilt and Power Trim systems. These motors are similar and need not be discussed separately. Both motors disassemble and test the same.

TROUBLESHOOTING

1. Check battery condition.
2. Check wiring against wiring diagram to determine if unit is wired correctly.
3. Eliminate control panel switches and harness to determine if cause for pump motor not running is in control panel switches and wiring or in pump motor. To do this, proceed as follows (refer to Figure 1):

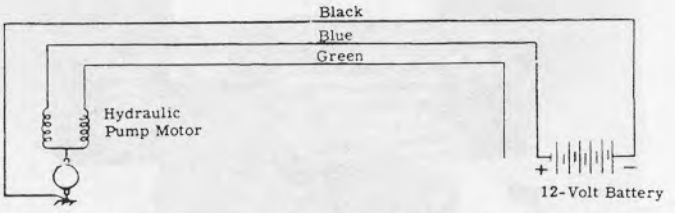


Figure 1. Schematic Diagram of Hydraulic Pump Motor Harness

CONNECTED DIRECTLY TO BATTERY -- "UP" POSITION

a. Remove black wire in pump motor harness from engine terminal block.
b. Remove blue wire in pump motor harness from control panel terminal block.
c. Connect black wire (removed in Step "a") directly to negative (-) battery terminal.
d. Connect blue wire (removed in Step "b") directly to positive (+) battery terminal. Pump motor should run and unit should tilt up.
e. If pump motor does not run in Step "d", hydraulic pump motor or pump and valve assembly are defective.
f. If pump motor runs in Step "d", check control panel switches and wiring as follows (refer to Figure 2):

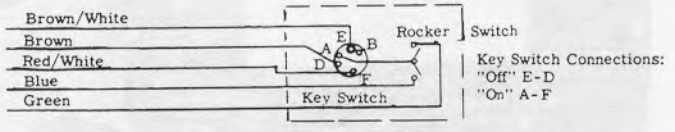


Figure 2. Schematic Diagram of Control Panel Harness

(1) Remove red/white and blue wires in control panel harness from control panel terminal block.

(2) Connect one lead from a continuity meter to terminal on red/white wire and other continuity meter lead to terminal on blue wire.

(3) Turn control panel key switch to "On" position and depress top of rocker switch. While holding switch in, note reading on meter. Meter must show full continuity.

(4) If full continuity is not noted in Step (3), connect one continuity meter lead to "F" terminal on back of control panel key switch. Connect other test lead to "A" terminal on back of control panel key switch. With control panel key in "On" position, meter must show full continuity.

(5) If full continuity is noted in Step (4), remove test lead from "F" terminal and connect it to terminal (on back of rocker switch) which has blue wire soldered to it. Depress top of rocker switch and, while holding switch in, note reading on meter. Meter must show full continuity. If meter does not, rocker switch is defective.

(6) If checks made in steps (4) and (5) indicate that control panel switches are OK, red/white and/or blue wires may be open. These wires should be tested by connecting one test lead to each end of wire. If either of these wires does not show full continuity, control panel harness is defective.

DISASSEMBLY and TESTING

1. Remove 2 screws from top of motor and reservoir assembly.
2. Separate reservoir and motor.
   a. Scribe a mark on housings to assist in reassembly.
   b. Be cautious not to lose spacer from armature.
3. Pull armature out of frame and field assembly.
4. Check and clean armature as follows:
   a. If commutator is worn, it can be turned down on an armature conditioner tool or on a lathe. Mica must be undercut after reconditioning.
   b. If not worn badly, clean armature with "OO" sandpaper.
   c. Check armature on a growler or with Magneto Analyzer (C-91-25213). Any indication of shorts or open windings requires replacement of armature.
5. Remove ground wire from upper end cap.
6. Remove upper end cap from frame and field assembly.
7. Inspect condition of brushes. Replace, if pitted or worn to one-half original length.
8. Replace brush by either of 2 procedures, as follows:

   NOTE: Standard rosin core solder cannot be used for brush replacement, as it would interfere with thermal cut-out switch.

   a. Cut worn brush shunt, so that a short piece is left, and connect new brush lead to old lead with an Amplivar Splice (C-42775) or equivalent. Splice can be soldered to ensure connection.
   b. Cut old brush shunt at brush box and solder a new brush shunt with high temperature solder. This solder preferably should have a high tin content and some silver with melting point around 500°F + (260°C+). Since silver solder generally requires use of a torch, care should be taken not to burn motor insulation.

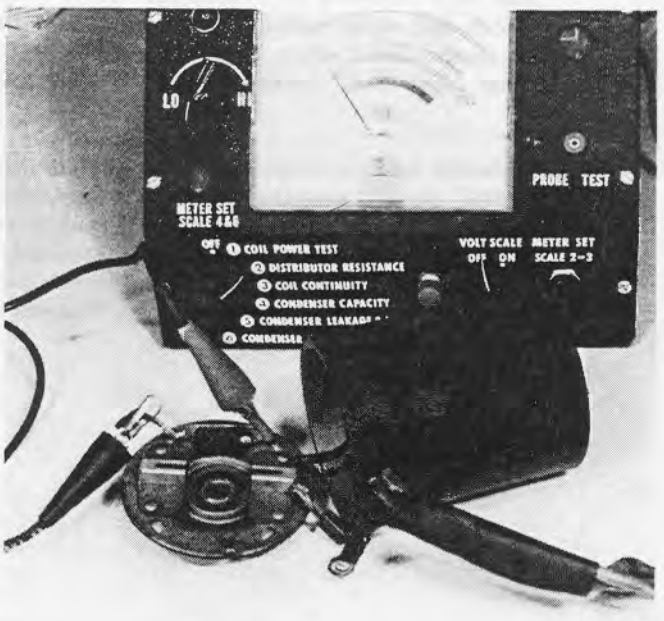


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Figure 3. Checking between Brush Pigtail and Thermal Switch

9. Clean and inspect end cap.
   a. Check thermal switch for resistance. With Magneto Analyzer (C-91-25213) set on scale No. 2, check between brush pigtail and opposite end of thermal switch. (Figure 3) If thermal switch indicates high resistance, replace end cap.
   b. Check between brush holders and end cap for shorts. Set Magneto Analyzer on scale No. 3 or VOA (Volt-Ohm-Amp) tester on R x 1 scale. With one lead on brush pigtail and other on end cap, no continuity should be indicated. (Figures 4 and 5) If any short is indicated, replace end cap.

03258

Figure 4. Checking between Brush Pigtail and End Cap

10. Clean and inspect frame and field assembly.
    a. Set Magneto Analyzer (C-91-25213) on scale No. 2.
       (1) Check for resistance between green wire and black jumper wire. (Figure 6)

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Figure 5. Checking between Brush Holders and End Cap

(2) Check for resistance between blue wire and black jumper wire.
(3) Check black ground wire for resistance.
(4) High resistance on any of the preceding checks requires replacement of frame and field assembly.

b. With Magneto Analyzer set on scale No. 3, or VOA (Volt-Ohm-Amp) tester on R x 1 scale, check for short between black jumper wire and frame. If indicator needle moves to the right, a short between field and frame exists, and replacement is required.

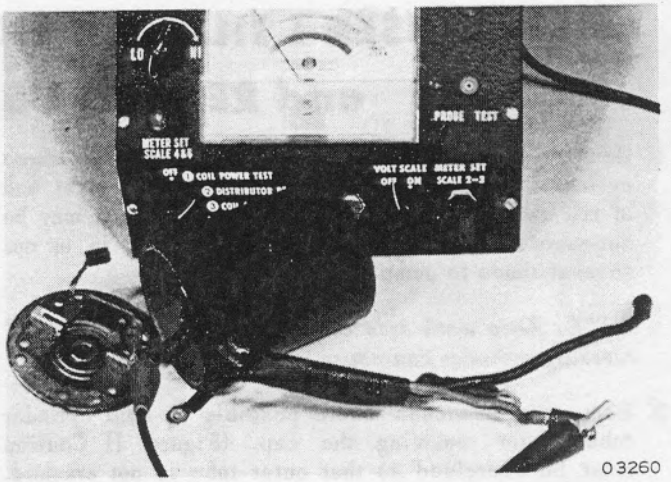

Figure 6. Checking between Green Wire and Black Jumper Wire

REASSEMBLY

CAUTION: Work area must be dust-and-lint-free. Slightest amount of dirt in hydraulic system will cause pump malfunction.

1. Install armature into frame and field assembly.
2. Install upper end cap assembly.
   a. Depress brushes into holders and slide over commutator bars.
   b. Do not chip or mar brushes.
3. Install screws into cap, including ground wire under one screw.

MERCRUISER I TILT and SHOCK CYLINDER DISASSEMBLY and REPAIR, USING KIT B-38592A1

1. Remove plug and seal (seal is not installed where cylinder is used as a tilt cylinder) from pivot end of tilt cylinder and drain oil from cylinder. It may be necessary to manually move piston shaft in or out several times to pump oil from cylinder.

   NOTE: Keep work area clean, as any foreign material entering cylinder can cause a malfunction.

2. Use strap wrenches where possible to hold cylinder tube while removing the cap. (Figure 1) Caution must be exercised so that outer tube is not crushed. If necessary to use slip-joint pliers, wrap leather or cloth strips under jaws of pliers to prevent damage.

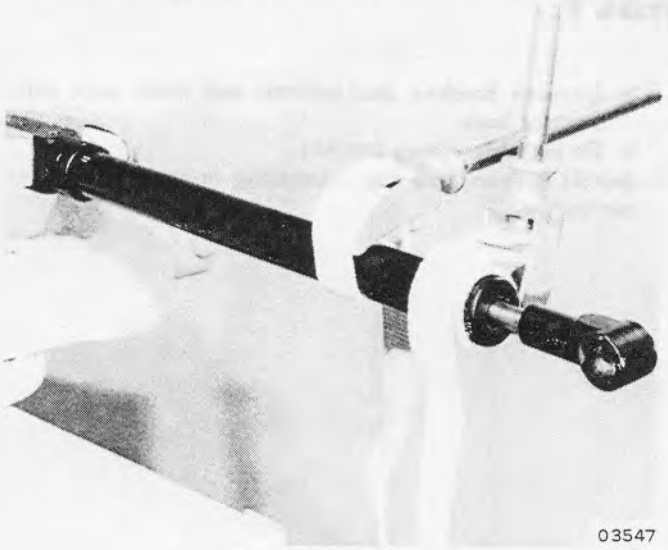

Figure 1. Removing End Cap

3. While holding tube in place, remove end cap (right hand thread) and pull piston shaft, seal retainer and piston assembly from tube.

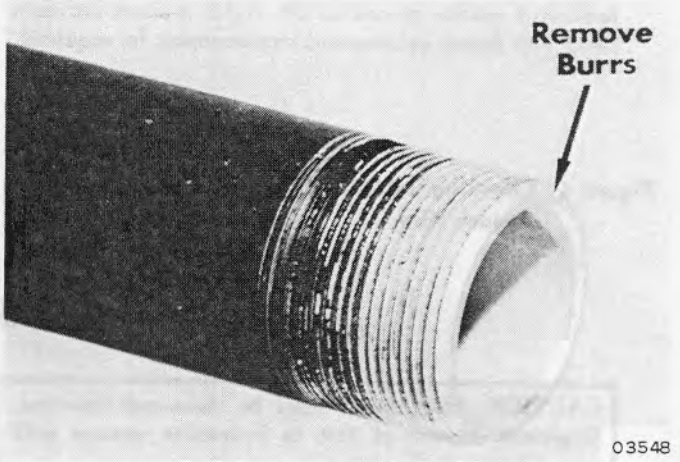

Figure 2. Burrs Removed from Tube

NOTE: If tube unscrews from pivot end, remove, clean and apply Loctite (C-92-36088) or a good grade pipe sealer on threads. Reinstall and torque to 50-55 ft. lbs. (6.90 mkg-7.59 mkg)

4. Remove top locking nut from end of piston shaft and slide off piston assembly, "O" ring, seal retainer and scraper.
5. Clean all parts and make certain that no chips or burrs remain on any parts. Remove burrs from inside edge of tube. (Figure 2)
6. Place end cap, scraper, washer (smooth, radiused side of washer next to "O" ring), "O" ring and seal retainer on piston shaft. (Figure 3)

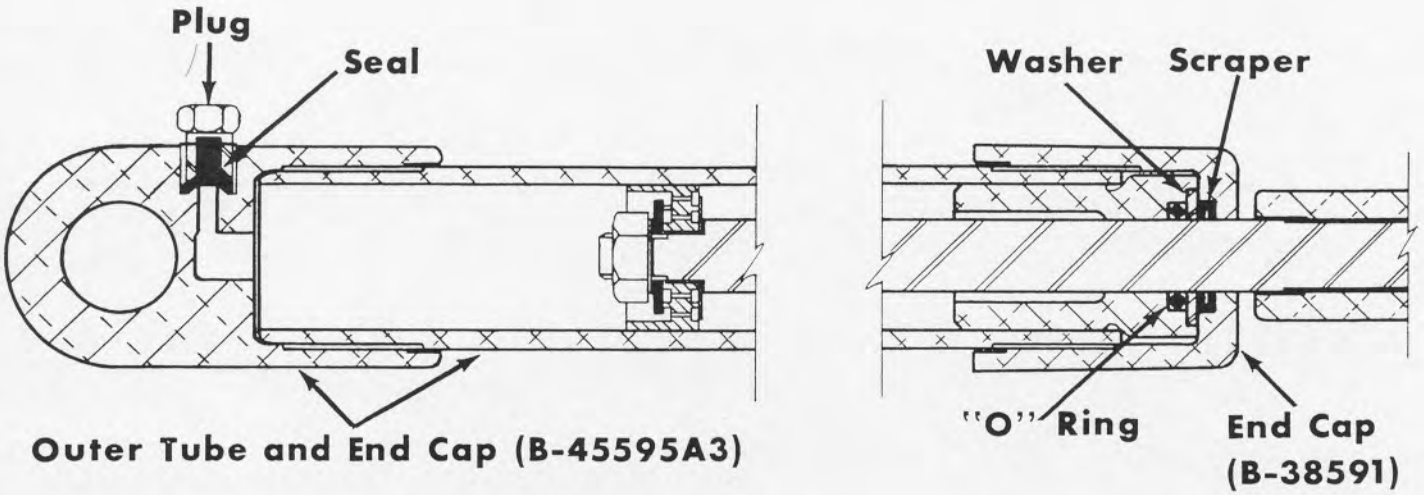

Figure 3. Piston Shaft

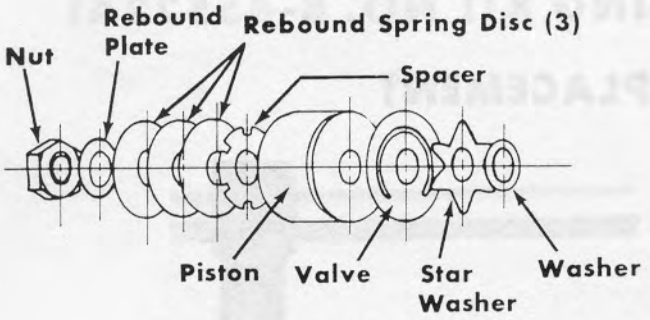

Figure 4. End of Piston Shaft

7. Place washer, star washer, piston intake valve, piston metering washer spacer, rebound spring disc (3 required), rebound plate and nut on end of piston shaft in order shown in Figure 4.
8. Torque nut to 10-12 ft. lbs. (1.38mkg-1.76mkg)
9. Clean threads on end cap and outer tube and place a coating of Anti-Corrosion Grease (C-92-45134A1) on threads.
10. Cylinder must be completely filled with oil and free of air when cylinder is fully retracted. Fill cylinder as follows:
    a. Fill cylinder with MS rated 20W oil.
    b. Install plug and seal into pivot end of cylinder and fill tube with oil. (Figure 3)
    c. Place piston assembly and seal retainer into outer tube. (Figure 5) Be sure "O" ring and washer are seated into recess of retainer, but do not push piston rod into tube at this time.

NOTE: Place a small amount of Multipurpose Lubricant (C-92-49588) on "O" ring to ease installation.

    d. Thread end cap onto outer tube and tighten to a torque of 50-55 ft. lbs. (6.90 mkg-7.59 mkg)
    e. Remove plug and seal (seal is not installed where cylinder is used as a tilt cylinder) from pivot end and stand cylinder on end with plug hole up, allowing air to flow to top and out of port. Slowly push piston rod into cylinder, allowing excess oil to run out.
    f. When piston rod is fully retracted into cylinder, reinstall seal and plug into pivot end.
11. Check operation by manually extending piston rod. Piston should offer more resistance while extending than when retracting. Motion should be free and not bind in either direction.
12. Sand down and retouch scratches, nicks, etc, with paint for corrosion protection.

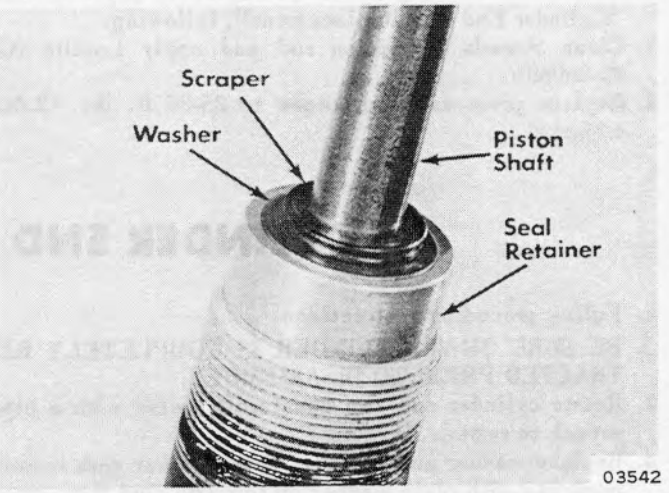

Figure 5. Installing Piston Assembly

TRIM CYLINDER REPAIR, USING KIT NO. B-45522A1

PIVOT END REPLACEMENT

1. Retract piston rod before clamping in vise.
2. Secure stainless steel piston rod in vise (with soft jaws, to prevent scoring piston shaft) as close to pivot end as possible. (Figure 1)
3. Place steel bar thru eye of pivot end and rotate counterclockwise to remove. If pivot end is extremely tight, apply heat. EXTEND PISTON ROD COMPLETELY WHEN HEATING only the pivot end. DO NOT OVERHEAT, or "O" rings in cylinder will be damaged. (Rod should be cool to touch at entrance to cylinder.)
4. If cylinder end cap is to be replaced, proceed with "Cylinder End Cap Replacement", following.
5. Clean threads on piston rod and apply Loctite (C-92-36088).
6. Replace pivot end and torque to 25-30 ft. lbs. (3.46-4.15mkg).

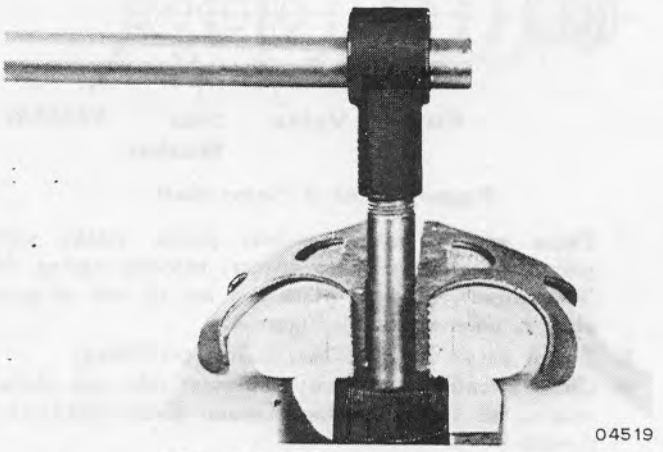
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Figure 1. Piston Rod in Vise

CYLINDER END CAP REPLACEMENT

1. Follow preceding instructions.
2. BE SURE THAT CYLINDER IS COMPLETELY RETRACTED PRIOR TO DISASSEMBLY.
3. Rotate cylinder end cap counterclockwise with a pipe wrench to remove. (Figure 2)
4. Replace washer and scraper. Scraper must seat evenly in recess with plain washer on top. (Be sure that scraper [rubber] fully encloses metal scraper before seating into recess.) (Figure 3)
5. Coat threaded area of tube with Quicksilver Anti-Corrosion Grease (C-92-45131).
6. Replace end cap, torquing to 35-45 ft. lbs. (4.84-6.22 mkg).
7. Install pivot end as outlined above.
8. Paint over scratches and scrapes to protect exposed metal from corrosion.

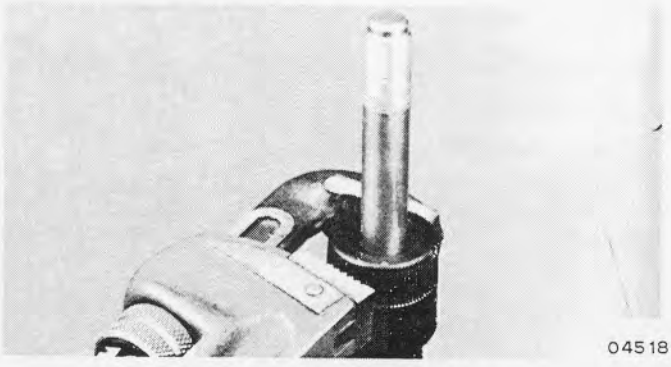
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Figure 2. Removing End Cap

9. Install repaired cylinder on unit. Make sure that grounding spring is placed properly. Be sure that one small spiral spring is installed between rubber bushings on each side of each pin. (Figure 4)

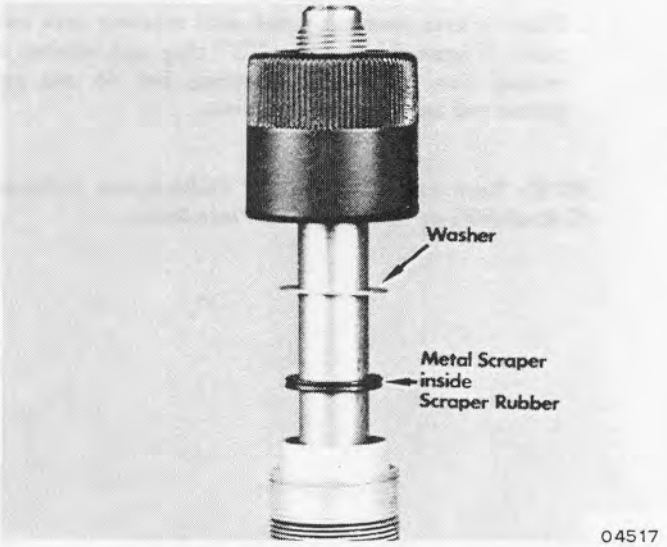

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Figure 3. Scraper

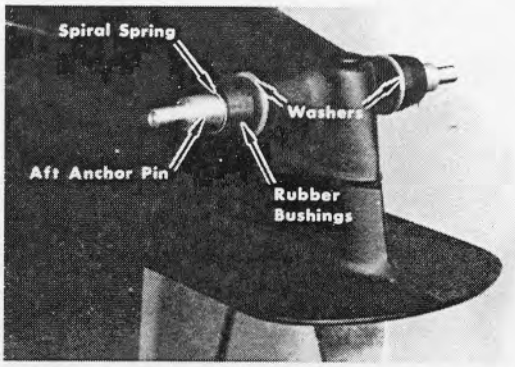

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Figure 4. Spiral Spring Installed

HYDRAULIC TRIM INDICATOR SENDER

REMOVAL

Remove bolts from bracket and remove sender.

DISASSEMBLY

1. Remove 4 thru bolts to remove end caps and piston.
2. Hold piston shaft end, remove nut and washer and slip piston assembly from shaft.
3. Separate piston halves. Be careful not to lose bypass valve pins, check balls and spring. See Figure 1 for typical assembly.

IMPORTANT: Keep all parts clean. Work in a clean area. Lubricate parts during assembly with type "A" hydraulic fluid.

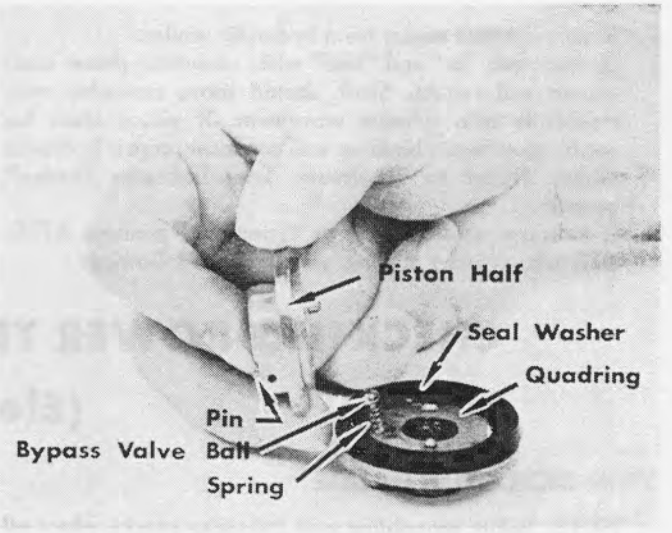

Figure 1. Typical Piston and Valve Parts

REASSEMBLY

1. Place new seal washer and quadring on piston half and reassemble piston on shaft, being careful to replace bypass valve parts. (Figure 2) Tighten nut securely.
2. Pick "O" ring from shaft side end cap (being careful not to disturb staked washer) and install new "O" ring. (Figure 3)
3. Install new quadrings in both end caps.
4. Reassemble sender and tighten thru bolts securely. This completes sender reassembly.

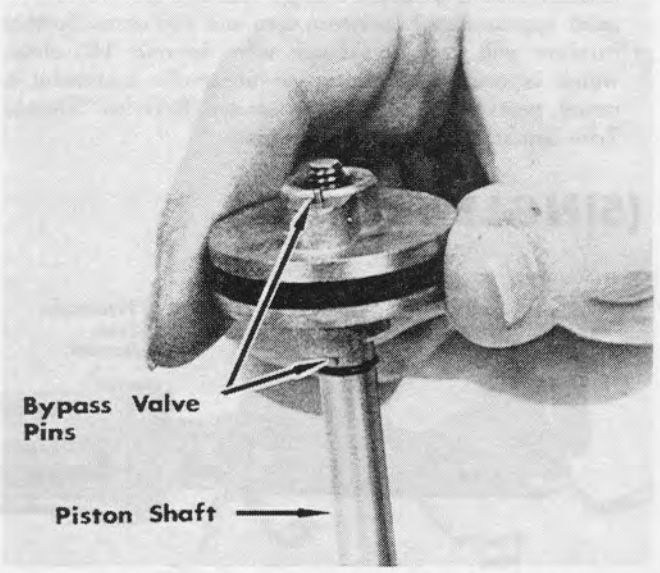

Figure 2. Typical Piston Shaft Assembly

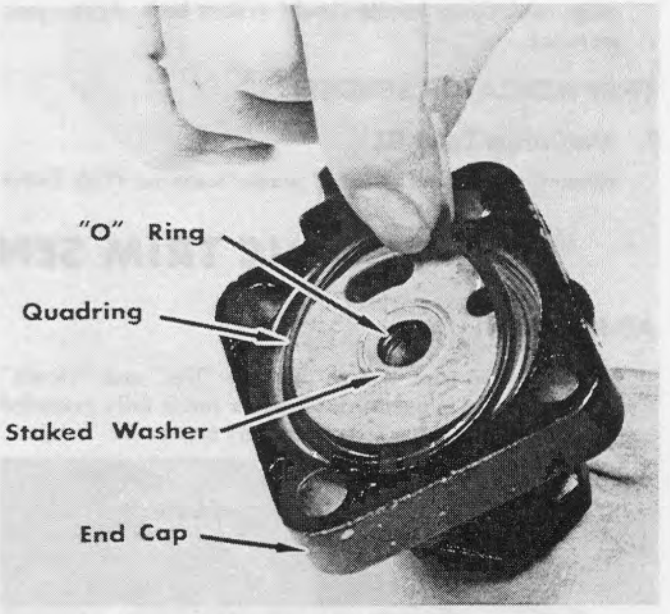

Figure 3. Typical End Cap Assembly

CHECKING POWER TRIM INDICATOR SYSTEM (Hydraulic)

NOTE: Be sure that Power Trim system is free of air before proceeding with following check. (Refer to "Bleeding Procedure", preceding.)

1. Remove electric sender from hydraulic sender.
2. Operate trim "in" and "out" while observing piston shaft extend and retract. Shaft should move smoothly with respect to trim cylinder movement. If piston shaft has erratic movement, binds or will not move, repair hydraulic sender. (Refer to "Hydraulic Trim Indicator Sender", preceding).
3. If indicator needle moves to "Trim Out" position WITHOUT trim cylinder moving, complete the following:
   a. Follow "Electric Trim Indicator Gauge" and "Electric Sender Check", following.
   b. If electrical system checks good, watch sender piston shaft while boat is underway. If, after a time, piston shaft retracts or can be pushed in with very light finger pressure, repair hydraulic sender. (Refer to "Hydraulic Trim Indicator Sender", preceding).
4. If indicator needle moves to "Trim Out" position with trim cylinders moving "in", complete the following:
   a. Follow "Electric Trim Indicator Gauge" and "Electric Sender Check", following.
   b. If electrical system checks good, trim cylinder has an internal leak. (Refer to "Testing: Cylinder Checks", preceding).

CHECKING POWER TRIM INDICATOR SYSTEM (Electrical)

TRIM INDICATOR GAUGE

NOTE: Before proceeding with following checks, check all terminals and connections for looseness and corrosion. Check wiring for open circuit. Refer to "Section 3, Electrical System Part E" for wiring diagrams.

1. Remove leads from gauge terminals.
2. Connect jumper lead from red lead on ignition switch terminal to "IGN" terminal on gauge. Gauge needle should deflect beyond red arc.
3. Without removing jumper lead, ground other terminal to gauge case. Gauge needle should deflect back slightly past green arc.

TRIM INDICATOR SENDER

1. MerCruiser I and III

Remove sender and connect sender leads to VOA Tester (C-91-52751) (R x 1 scale). Push sender plunger in with pencil or similar object and note meter reading. Sender resistance should be approximately between zero and 160 ohms. If erratic or no needle movement is noted, replace and adjust new sender.

2. MerCruiser 215, 225 II-TR and 255 II-TR

Remove sender and connect sender leads to VOA Tester (C-91-52751) (R x 1 scale). Align mark on index shaft with mark on sender housing. Rotate sender hex shaft counterclockwise. Meter should indicate an even movement approximately between zero and 160 ohms. Further rotation will carry resistance valve beyond 160 ohms, which is normal. If erratic or no needle movement is noted, replace and adjust new sender. Refer to "Electric Trim Sender Adjustment", following.

ELECTRIC TRIM SENDER (SINGLE or DUAL)

ADJUSTMENT

1. Operate drive trim system fully to "Up" and "Down" positions. Hold in button until sender rod is fully extended (Figure 1) and trim cylinders are fully retracted.

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Figure 1. Output Shaft Extension

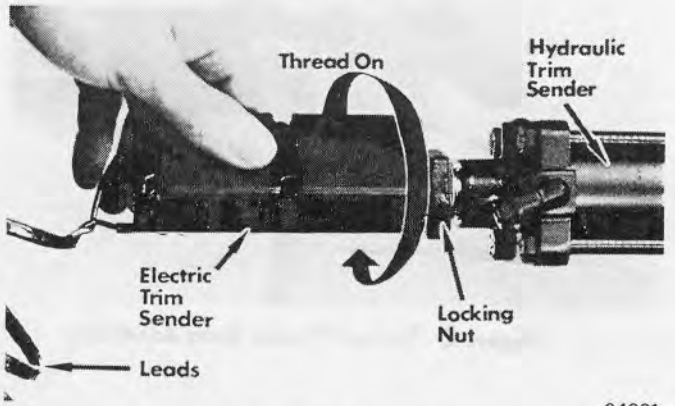

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Figure 2. Threading Electric Sender

2. Connect sender leads to connector block on engine.
3. Turn ignition key to "On" position.

4. Thread on electric sender (Figure 2) until panel indicator pointer is at bottom of green arc. (Figure 3)

   NOTE: Hydraulic tubing and fitting were removed from hydraulic sender in Figure 2 for clarity.

5. Tighten locking nut and turn off key switch.
6. Disconnect wiring to straighten leads, then reconnect.

INDICATOR READJUSTMENT

If unit was fully extended into trailer position, it may be necessary to synchronize the indicator by operating "In" button. Hold "In" button until trim cylinders fully retract.

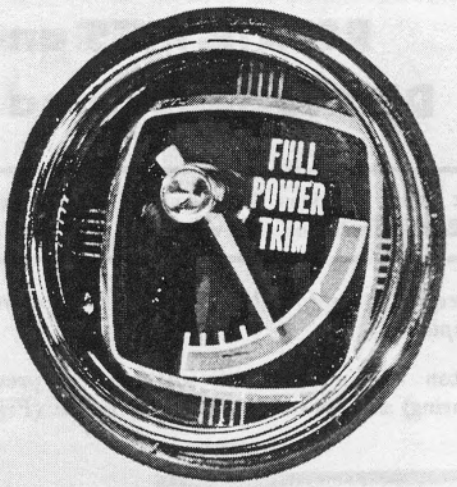

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Figure 3. Panel Indicator Pointer

MERCRUISER TRIM CYLINDER REPAIR KITS and PARTS REPLACEMENT DISASSEMBLY and REASSEMBLY PROCEDURE

CAUTION: Work in clean, lint-free area. Lubricate parts with 20W-MS rated oil after cleaning.

NOTE: Disregard Steps 1, 2, 17, 18 and 19, if pivot end is not to be replaced.

1. Secure piston rod in vise (with soft jaws to prevent possible scoring) as close to pivot end as possible. (Fig. 1)

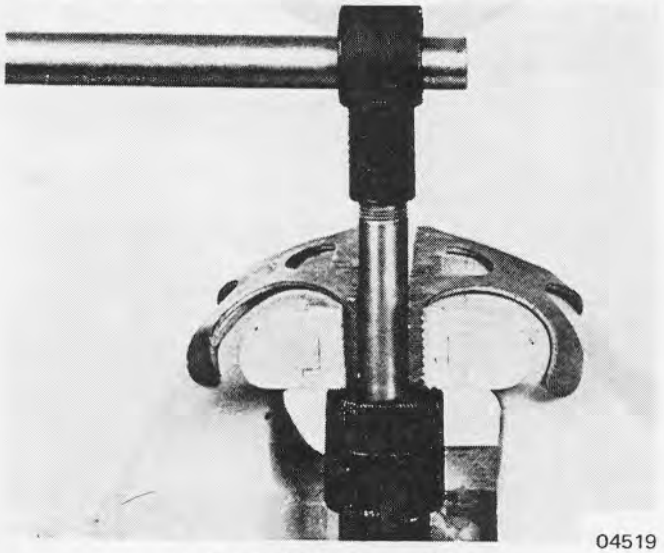


Figure 1. Piston Rod in Vise

2. Place a bar thru eye of pivot and rotate counterclockwise to remove. If pivot end is extremely tight, apply heat only with piston rod extended, being careful not to overheat cylinder parts.

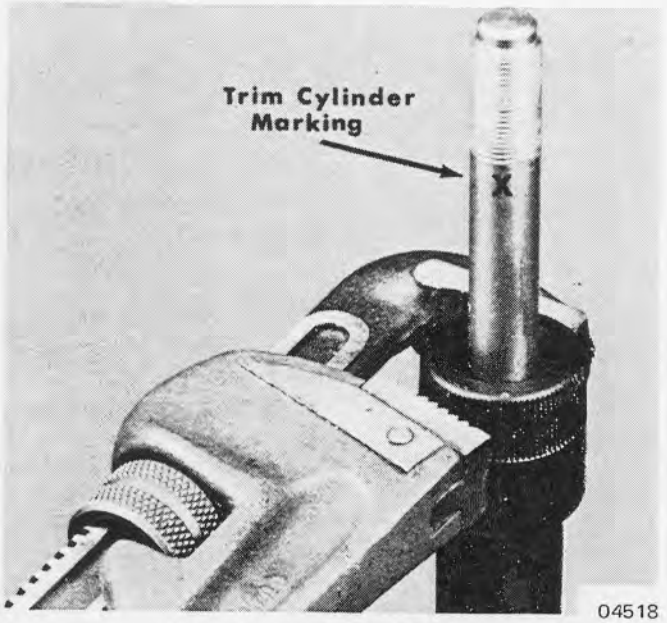


Figure 2. Removing End Cap

3. Rotate cylinder end cap carefully, counterclockwise with a pipe wrench to remove. (Figure 2)
4. Pull piston rod and piston rod bearing from cylinder. The inner cylinder can come with it.
5. Remove trim piston and tube guide. Use a wire hook to remove tube guide, if it remains in outer cylinder.

CAUTION: DO NOT remove or discard piston assembly if other than a major overhaul kit is used for repairs.

6. Place piston rod in vise, as in Step 1, and remove nut that retains piston assembly.
7. Remove piston assembly from piston rod and discard.
8. Remove piston rod bearing. Replace its inner and outer "O" rings.
9. Place plain washer, Equi-Flex scraper and piston rod bearing on piston rod.
10. Discard loose small shim washers in envelope. Use shim washers supplied with new piston only. Remove nut which holds new piston assembly together, being careful to hold assembly parts in position with a free hand.
11. Remove shipping bolt and washer from under piston head while holding piston upright. Place sealing washer in its proper piston upright. Refer to assembly drawing below. (Figure 3)

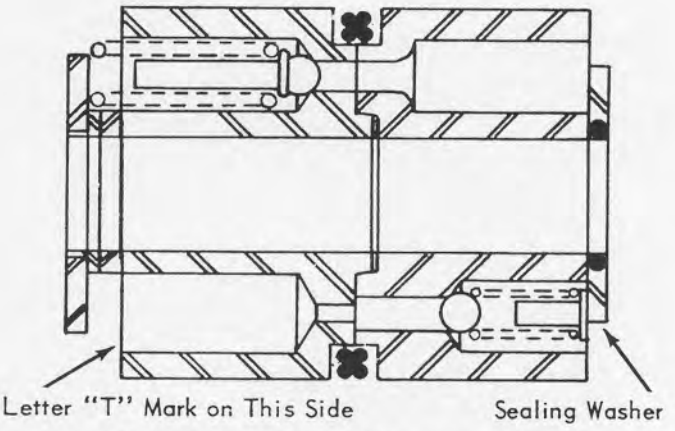


Figure 3. Piston Sealing Washer Location

12. Carefully place piston assembly over piston rod with sealing washer toward piston rod.
13. Install new nut and torque to 8-10 ft. lbs. Remove piston rod assembly from vise.
14. Place new "O" rings on floating piston and tube guide. Place them into inner cylinder and position them in the outer cylinder. Refer to assembly drawing. (Figure 4)
15. Insert piston rod and piston into inner cylinder while fitting piston rod bearing into outer cylinder.
16. Coat threads of outer cylinder with Anti-Corrosion Grease (C-92-45134) and install end cap. Torque to 35-45 ft. lbs.
17. Secure piston rod in vise as close to pivot end threads as possible. (Figure 1)

18. Clean threads on piston rod and apply Loctite (C-92-36088).
19. Replace pivot end and torque to 25-30 ft. lbs.
20. Paint over scratches to protect exposed metal.
21. After installation of these kits (B-45522A3 or C-25-60342A2), the repaired cylinder MUST BE MARKED with and "X" permanent stamp on the trim cylinder piston rod near the pivot end (if not already marked in this manner). (Figure 2)

NOTE: The letter "X" indicates that the latest inner cylinder and the latest piston assembly have been installed. (Figure 2) Markings "3" or "•••", which may be on the piston rod, indicate that the latest piston assembly has previously been installed.

CAUTION: Make sure that spiral grounding springs are properly installed between rubber bushing on each side of anchor pins when installing cylinders.

NOTE: Refer to appropriate section of MerCruiser Service Manual for bleeding Power Trim systems.

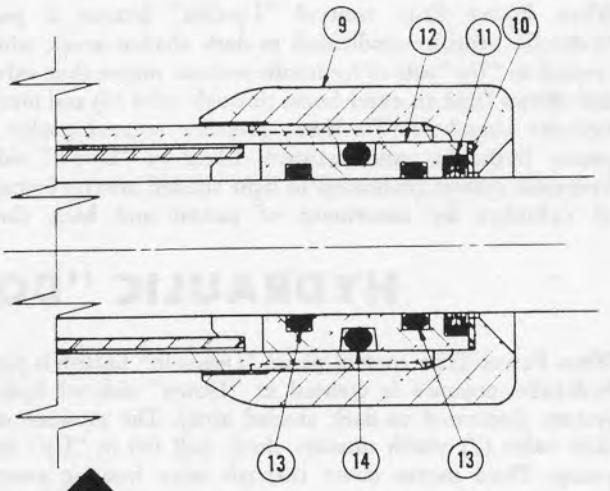
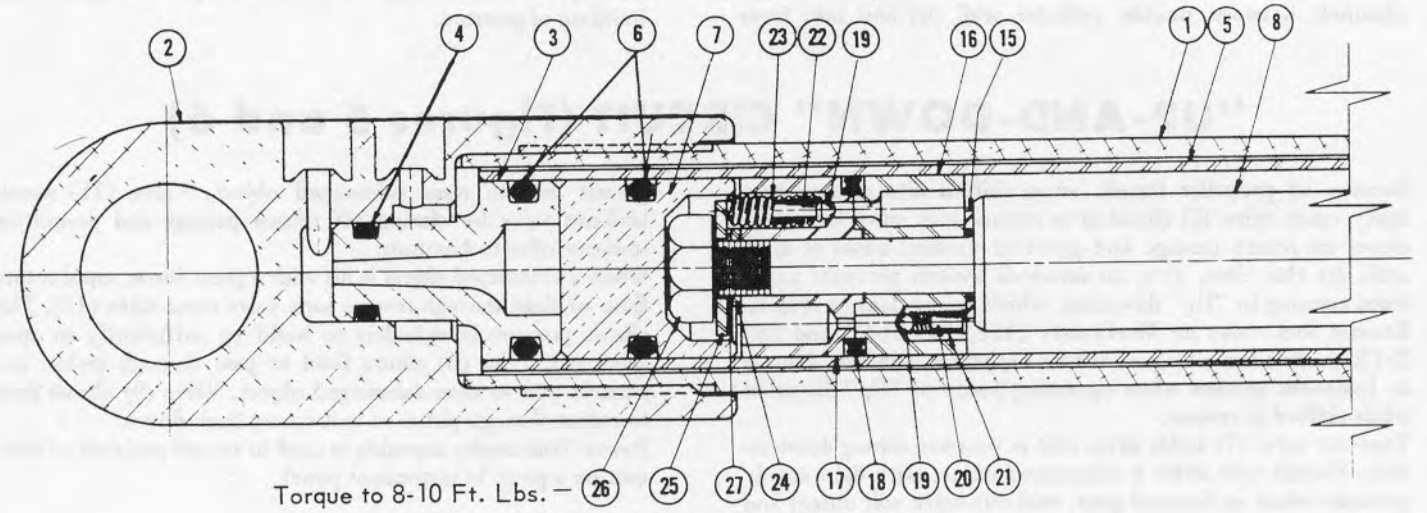


Figure 4. Cylinder Assembly Drawing



1 - Outer Tube Assembly
2 - End Cap - Gimbal Ring
3 - Inner Tube Guide
4 - "O" Ring
5 - Tube - Inner
6 - "O" Ring
7 - Piston - Floating
8 - Rod - Piston
9 - End Cap - Cylinder
10 - Washer - Plain
11 - Scraper - Rod (Equi-Flex)
12 - Bearing - Piston Rod
13 - "O" Ring
14 - "O" Ring
15 - Washer - Sealing
16 - Shock Piston - Return
17 - Shock Piston - Impact
18 - Quad Ring (or Seal Ring)
19 - Ball - Steel
20 - Rivet - Tubular
21 - Spring - By-Pass Check
22 - Rivet - Tubular
23 - Spring - Shock Relief
24 - Washer - Plain
25 - Washer - Plain
26 - Nut - 5/16-24 UNF-ESNA
27 - Washer - Plain

MERCRUISER POWER TRIM
HYDRAULIC CIRCUIT EXPLANATION
HYDRAULIC "UP" CIRCUIT (Figure 5)

When Power Trim control "Up-Out" button is pushed, hydraulic pressure (indicated in dark shaded area), which is created in "Up" side of hydraulic system, moves slide valve (2) and allows fluid to enter hoses through valve (4) and into trim cylinder chambers (3). Here, pressure created pushes dual piston hydraulic ram outward. Fluid in "Down" side of hydraulic system (indicated in light shaded area) is forced out of cylinders by movement of piston and back through connecting hoses, reverse lock valve, trim indicator assembly and valve (7) to pump reservoir.

Valve (15) regulates amount of "Up" pressure put out by pump.

Valve (13) is a back-up safety valve to protect system from a build-up of excessive pressure.

Valve (4) holds pressure in "Up" system when pump is not running and drive unit is shifted into forward.

HYDRAULIC "DOWN" CIRCUIT (Figure 6)

When Power Trim control panel "Down-In" button is pushed, hydraulic pressure is created in "Down" side of hydraulic system (indicated in dark shaded area). The pressure moves slide valve (2) which unseats check ball (4) in "Up" side of pump. Fluid moves down through valve housing assembly, connecting hoses and to trim indicator sender. Then, through sending unit, fluid operates sender and continues through connecting hose to reverse lock valve assembly. Fluid continues through reverse lock valve and down connecting hoses to trim cylinders. Finally, fluid travels into cylinders through channels between double cylinder wall (6) and into inner cylinder on "Down" side of cylinder piston. Hydraulic pressure moves piston inward, forcing fluid on "Up" side of system (3) (indicated in light shaded area) to return through connecting hoses, check valve (4) and used by pump gears to supply hydraulic "Down" circuit. Excess oil returns to pump reservoir (1) through valve (16) or (7).

Valve (16) regulates amount of "Down" pressure put out by pump.

Valve (12) allows fluid to travel through trim sender piston, when piston reaches end of travel, thus preventing excessive build-up of pressure.

"UP-AND-DOWN" CIRCUIT (Figures 5 and 6)

Because of propeller thrust, when shifted into reverse, normally open valve (5) (located in reverse lock valve assembly) closes oil return passage and prevents upward travel of drive unit. At this time, also, an interlock switch prevents pump from running in "Up" direction, which might damage system. Reverse lock valve on MerCruiser 215E, 225 II-TR and 255 II-TR models has a by-pass valve (14) which prevents damage to hydraulic system when operating pump in "Up" direction while shifted in reverse.

Trail-out valve (7) holds drive unit in position during deceleration. Should unit strike a submerged object with light steady pressure while in forward gear, trail-out valve will unseat and permit unit to clear submerged object. Valve (11) assists trail-out valve by closing off return passage and permitting trail-out valve to function.

When a submerged object is hit with a great force, rapid return flow of fluid through reverse lock valve seats valve (10). This allows pressure in cylinders to build up sufficiently to open valve (8). Valve (8) allows fluid to pass through piston and permits unit to clear submerged object. Valve (9) allows fluid to return through piston as unit comes back down.

Power Trim sender assembly is used to record position of drive unit on a gauge in instrument panel.

POWER TRIM - HYDRAULIC UP CIRCUIT

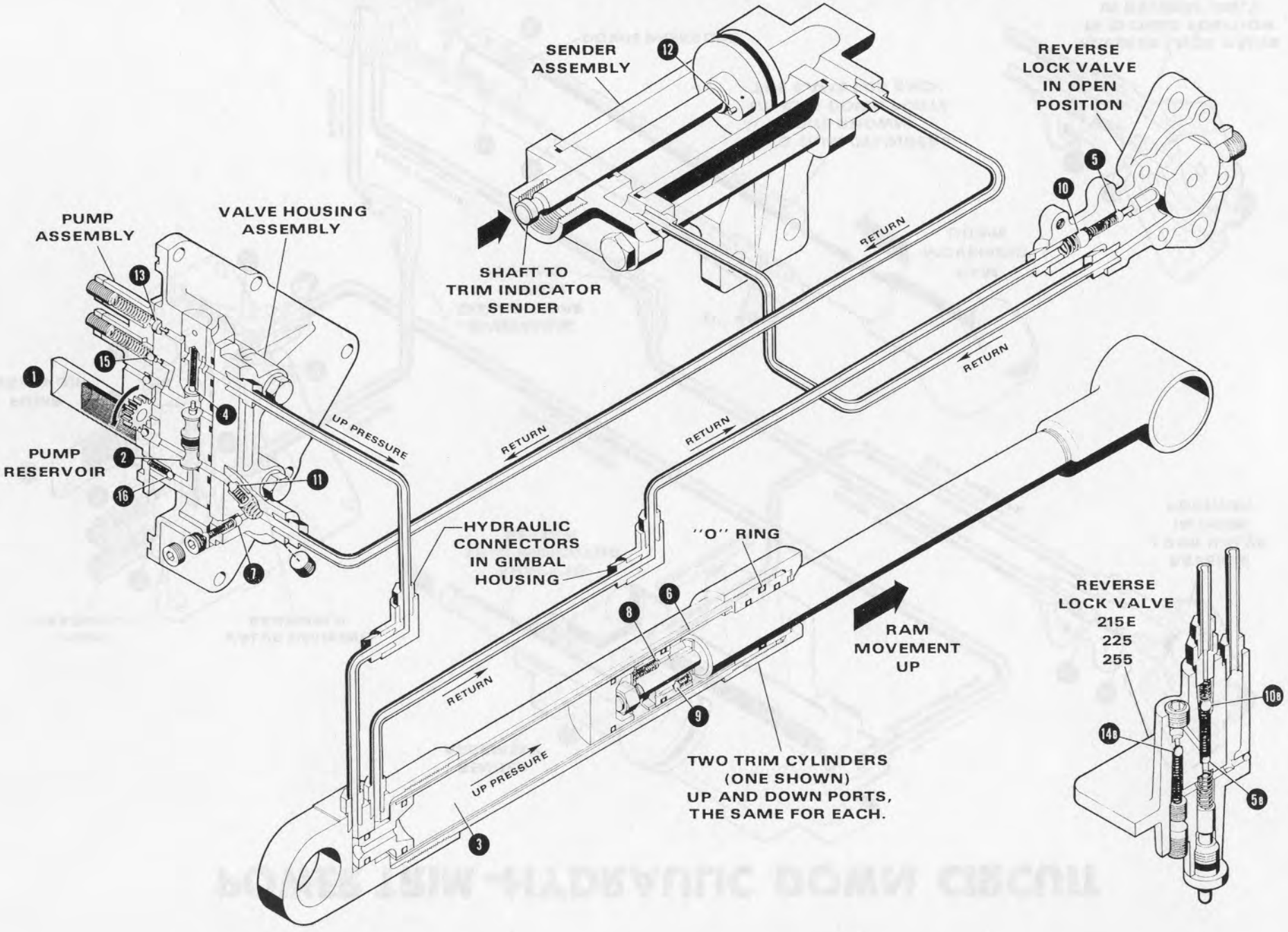


Figure 5. Hydraulic "Up" Circuit

POWER TRIM - HYDRAULIC DOWN CIRCUIT

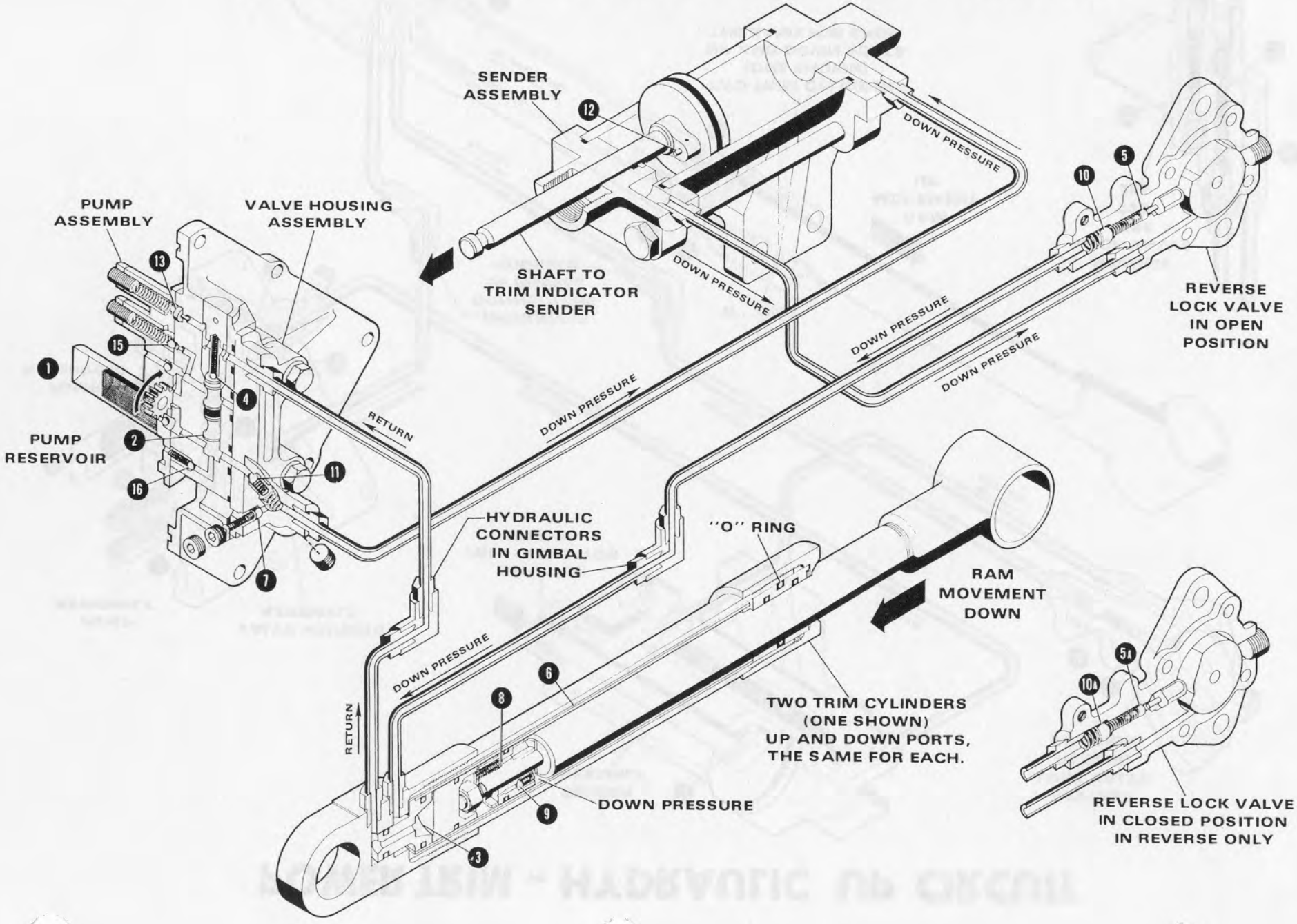


Figure 6. Hydraulic "Down" Circuit

SECTION 7-ACCESSORIES

MERCRUISER

PART B-STEERING SYSTEM

MERCURY MARINE

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PART B - STEERING SYSTEM

DESCRIPTION

The following pages provide maintenance instructions and adjustments for the Power Steering pump, cylinder and valve, oil cooler and power shift. Hydraulic pressure is delivered thru a hose from the pump to a valve which senses the requirement for power assistance and supplies the power cylinder accordingly.

CAUTION: Use a high-quality, name-brand type "A" hydraulic oil in hydraulic pumps.

TROUBLESHOOTING

The power steering system is relatively trouble-free, however, if Power Steering system does fail, refer to "Power Steering Trouble Diagnosis", following.

CAUTION: Do not operate engine without cooling water flowing thru water pump, or water pump will be damaged.

POWER STEERING TROUBLE DIAGNOSIS

NOTE: This chart covers only troubles caused by hydraulic power mechanism. Causes related to Ride-Guide system or cables also must be investigated. Hard steering usually can be traced to improper Ride-Guide cable installation.

PROBLEM/CAUSE	CORRECTION
1. Pump inoperative. Poor or no assist.	
a. Loose drive belt	a. Tighten belt.
b. Low oil level	b. Fill reservoir
c. Air in oil	c. Locate source of air leak and correct.
d. Defective hoses	d. Replace hoses.
e. Defective pump	e. Repair pump.
2. Momentary increase in effort when turning wheel fast to port (left) or starboard (right)	
a. Air in system	a. Bleed system.
b. Low oil level in pump	b. Check oil level in pump reservoir.
3. External oil leaks (steering unit)	
NOTE: Wipe unit and pump thoroughly and make sure that source of leakage is determined.	
a. Loose hose connections	a. Tighten.
b. Damaged hose.	b. Replace.
c. Cylinder piston rod seal	c. Replace seals.
d. Damaged or worn seals in valve	d. Replace seals.
4. External oil leaks (pump)	
a. Oil leaking at top of reservoir - too full	a. Remove oil down to proper level.
b. Oil leaking at top of reservoir caused by air bubbles in oil	b. Locate source of air leak and correct.
c. Reservoir "O" ring seal damaged or improperly installed	c. Replace "O" ring (kit).
d. Pressure union or reservoir to housing bolt and stud not tightened sufficiently	d. Torque union and stud and bolt to specifications.
e. Pressure union or reservoir to housing bolt and stud cross-threaded or damaged	e. Replace damaged parts.
f. Defective pressure fitting seat on hose end	f. Replace hose.
g. Damaged reservoir to housing or pressure union "O" ring seals	g. Replace seals (kit).
h. Defective shaft seal	h. Replace seal (kit).
i. Damaged shaft at seal area	i. Replace pump.
j. Leaks in metal parts	j. Replace pump.
5. Noise (pump)	
a. Loose belt	a. Tighten belt.
b. Hoses touching other parts of boat	b. Adjust hose positions.
c. Low oil level	c. Fill reservoir.
d. Air in oil	d. Locate source of air leak and correct.
e. Excessive back pressure caused by hoses or steering	e. Locate restriction and correct.
f. Defective pump	f. Repair pump.
6. Excessive wheel kickback or loose steering	
Air in system	Add oil to pump reservoir and bleed.
7. Steering wheel surges or jerks when turning with engine running.	
a. Loose pump belt	a. Adjust to specifications.
b. Air in oil	b. Locate source of air leak and correct.
c. Broken or weak valve spool spring	c. Replace valve assembly.

PROBLEM/CAUSE	CORRECTION
8. Hard steering while running	
a. Loose pump belt	a. Adjust to specifications.
b. Low oil level in reservoir	b. Fill to proper level. If excessively low, check lines and connections for leak.
c. Low oil pressure in steering cylinder caused by restriction in hoses	c. Check for kinks in hoses. Check for foreign object in hose.
d. Pressure loss in cylinder due to worn piston ring or scored housing bore	d. Replace cylinder.
e. Loose fit of spool in valve body or leaky valve body	e. Replace valve assembly.

POWER STEERING PUMP

DESCRIPTION

Hydraulic pump is engine-driven vane-type that is not repairable and must be replaced if defective.

REMOVAL and INSTALLATION

1. Disconnect hoses at pump. When hoses are disconnected, secure ends in raised position to prevent loss of oil. Cap with plug or tape ends of hoses to prevent entrance of dirt.
2. Install 2 caps or plugs at hose fittings to prevent loss of oil from pump.
3. Loosen belt tension brace nut and bolt where brace attaches to pump brace bracket.
4. Loosen and remove pump drive belt.
5. Remove pump from pump mounting bracket.
6. Remove drive pulley attaching nut.
7. Remove pulley from shaft with appropriate puller tool.

CAUTION: Do not hammer pulley off shaft, as this will damage pump.

PRESSURE GAUGE INSTALLATION and SYSTEM CHECK

1. Pressure Gauge (C-91-38053A1) and Hose (B-32-36338) are required when adjusting steering. Connect gauge and hose as follows, making connections as quickly as possible to prevent fluid from draining out of hoses and pump.
   a. Connect straight end of B-32-36338 hose to gauge tee, as shown in Figure 1.
   b. Remove pressure hose from back of pump and connect other end of B-32-36338 Hose to pump.
   c. Connect hose, which was removed from pump, to gauge tee, as shown in Figure 1.

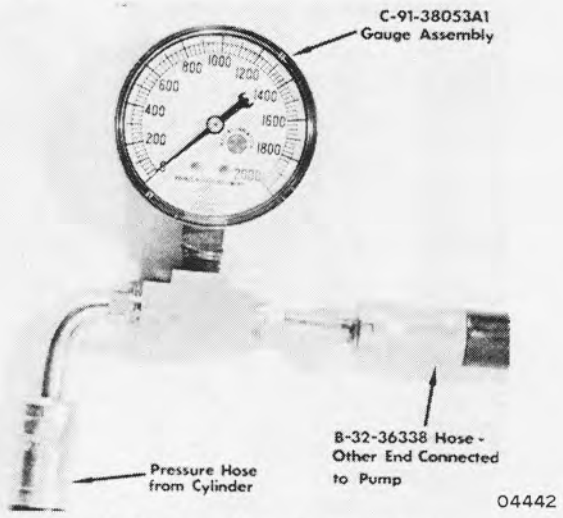


Figure 1. Pressure Gauge Connections

2. Remove shipping cap from pump and add type "A" automatic transmission fluid, as required, to bring level up to full mark on dipstick which is attached to fill cap. Do not install cap at this time.
3. Start engine and run at idle speed while, simultaneously, observing fluid level in pump reservoir. Do not allow fluid level to drop from sight, as air will be induced into system.

IMPORTANT: DO NOT operate engine without cooling water flowing thru water pickup pump, or pump will be damaged. Engine may be operated with boat out-of-water, if instructions, outlined under "Flushing" in "Operation and Maintenance Manual", are followed.

4. With assistance of another person, turn steering wheel back-and-forth to end of its travel in each direction (engine running at idle speed) and, at the same time, observe fluid level in pump reservoir. Add fluid, as required, to keep level visible in reservoir. Do not allow level to drop from sight, as air will be induced into system. Continue turning wheel back-and-forth until fluid level remains constant. If fluid is extremely foamy, stop engine and allow air to disperse. Then repeat above procedure until level remains constant.
5. Stop engine and check fluid level with dipstick. Add fluid, as required, to bring level up to full mark. Do not over-fill. Install cap with dipstick.

POWER STEERING (B-36259A1)

ADJUSTING STEERING

1. Remove pressure line from pump and install Pressure Gauge (C-91-38053), as shown in Figure 2.

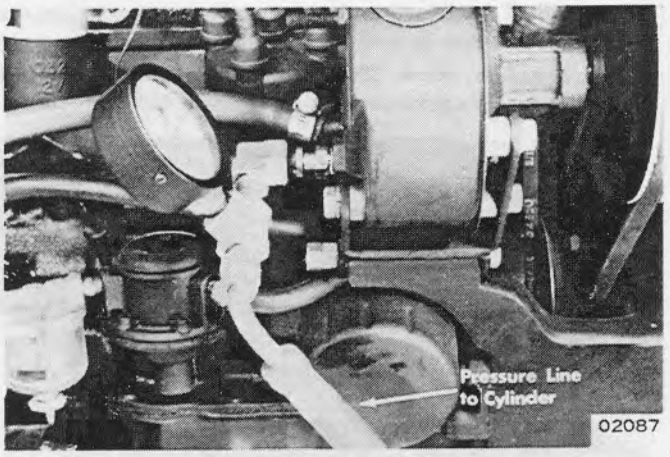


Figure 2. Pressure Gauge Installed

2. Start engine and allow to run at idle.

> **CAUTION:** Do not operate engine without cooling water flowing thru water pump, or water pump will be damaged.

Observe pressure gauge. Turn steering wheel as required until pressure shown on gauge is at lowest point. Allow engine to run for approximately 10 minutes before proceeding with adjustments. Check pump oil level and add type "A" transmission oil as necessary.

3. Adjust nuts ("A" in Figure 3) and cable guide tube so that approx. ½" (12.7mm) of threads extend between cable nut and tube locking nut "A", then back off both locking nuts ("A") so that there is approx. ¼" (6.4mm) of space between nuts "A" and mounting lug.
4. Turn steering wheel counterclockwise until gear rack in wheel bottoms out.
5. Push steering lever ("B" in Figure 3) as far as it will go toward starboard side of boat. At this point, steering link rod should line up with cable end. Adjust nuts "A", if necessary. Secure "C" with cable end and tighten nuts "A" against mounting lug.
6. Turn steering wheel clockwise one full turn, then turn counterclockwise until wheel bottoms out. Observe pressure gauge while holding wheel in this position. If pressure indicated on gauge is above 100 PSI, adjust cable guide tube on transom plate by loosening nuts and moving tube toward port side until pressure is below 100 PSI when steering wheel is bottomed out in counterclockwise direction.
7. Back out stop screw. Turn steering wheel clockwise until pressure gauge indicates an increase in pressure. Turn stop screw back in until pressure drops below 100 PSI, while lightly holding steering wheel.
8. Stop engine and install dirt shield on cylinder.
9. Remove pressure gauge from pump. Connect hose to pump as quickly as possible to prevent fluid from running out of pump and line.
10. Start engine and run momentarily at idle. Turn steering wheel back-and-forth several times.
11. Stop engine and check fluid level on dipstick. Add fluid if required.

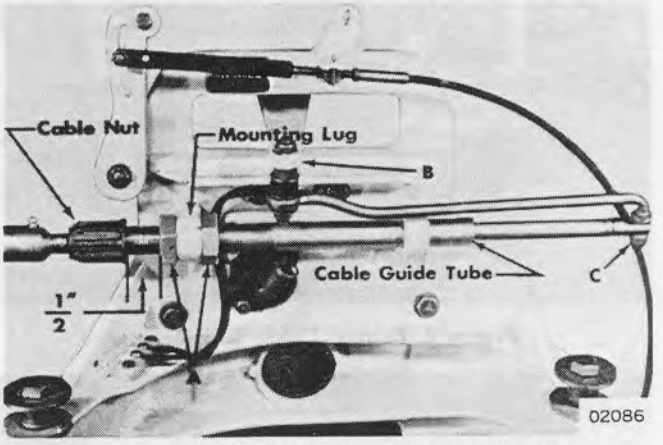


Figure 3. Output Cable Attached to Drive Unit

POWER STEERING (B-52777A1-A2)

1. Start engine and run at 600-700 RPM.

   IMPORTANT: Do not operate engine without cooling water flowing thru water pickup pump.

2. Turn steering wheel counterclockwise to end of its travel.
3. With steering wheel positioned as in preceding Step 2, connect output cable to drive unit as follows (Figure 4 or 5):
   a. Insert output cable thru cable guide tube and tighten coupler nut securely on tube.
   b. Push steering lever to right (starboard) to end of its travel.
   c. Loosen adjusting nuts on cable guide tube and position tube, as required, so that link rod or steering lever yoke can be connected to output cable.
   d. Fasten output cable to link rod or yoke.

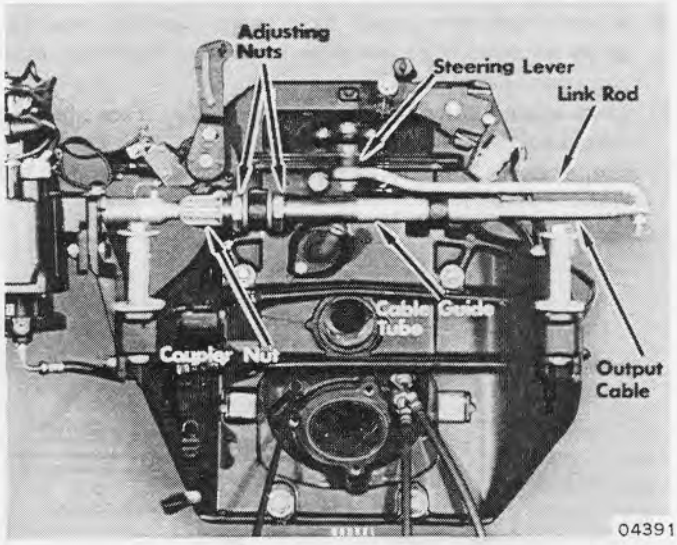


Figure 4. Output Cable Connections

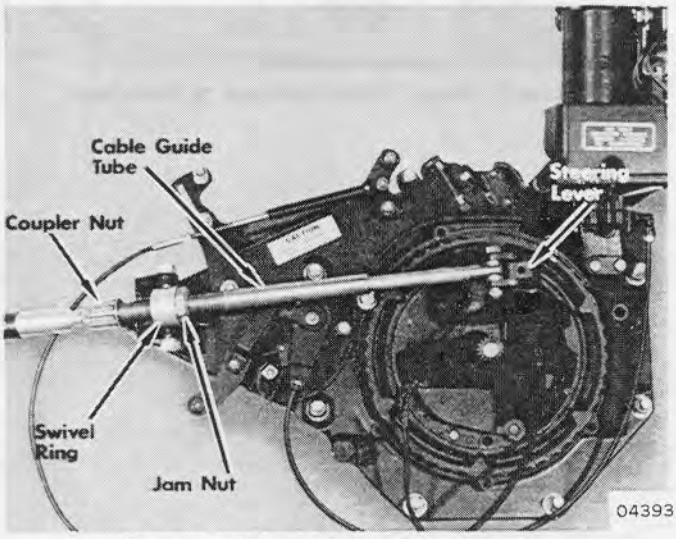


Figure 5. Output Cable Connections

4. Turn steering wheel clockwise one full turn, then turn counterclockwise to end of its travel. Observe Pressure Gauge (C-91-38053A1) while holding wheel in this position. If pressure on gauge indicates above 200 PSI, adjust cable guide tube on transom plate until pressure is below 200 PSI. Tighten nuts securely.
5. Turn steering wheel clockwise until drive unit pivots to end of its travel and pressure increases. Turn stop screw (located on cylinder) in until pressure indicated on gauge is below 200 PSI. Tighten stop screw jam nut securely against cylinder. (Figure 6)

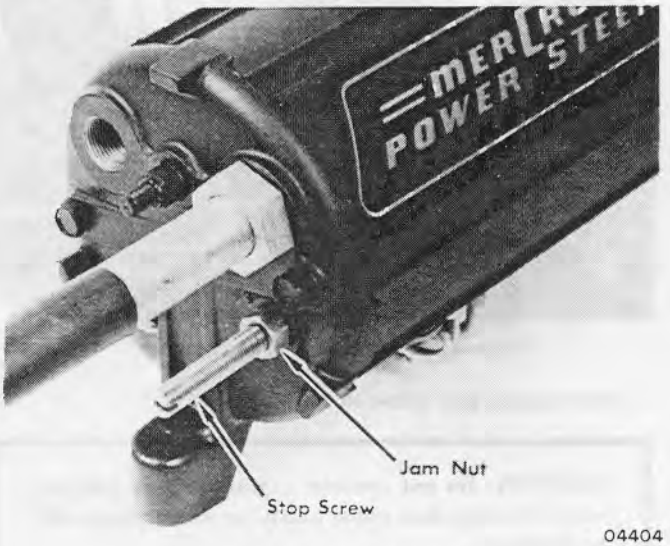


Figure 6. Stop Screw

6. Stop engine and remove pressure gauge from pump. Connect hose to pump as quickly as possible to prevent fluid from draining out of pump and hose.
7. Install cable access hole covers on cylinder. (Figure 7)

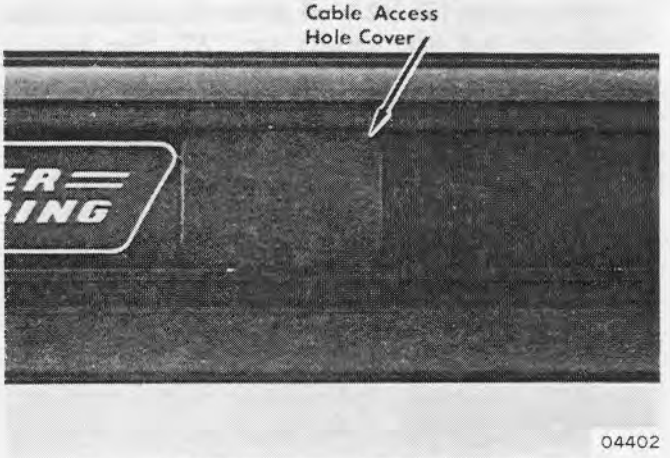


Figure 7. Cable Access Hole Cover Installed

8. Start engine and run at idle. Turn steering wheel back-and-forth several times.
9. Stop engine and check fluid level on dipstick. Add fluid, if required.

NOTE: After reinstallation, if more steering effort is required in one direction than in the other, the control valve must be adjusted (balanced).

POWER STEERING for MERCRUISER III

ADJUSTING STEERING - RIGHT or LEFT SIDE MOUNTING

1. Start engine and run at 600-700 RPM in neutral gear.

   IMPORTANT: Do not operate engine without cooling water flowing thru water pickup pump.

2. Turn steering wheel clockwise for right side mounted (counterclockwise for left side mounted) and adjust cable guide tube position on steering unit (by loosening adjusting nuts and moving tube) so that steering wheel gear rack is at end of its travel, steering lever is at end of its travel and pressure indicated on gauge is below 100 PSI. Tighten adjusting nuts securely. (Figure 8 or 9)

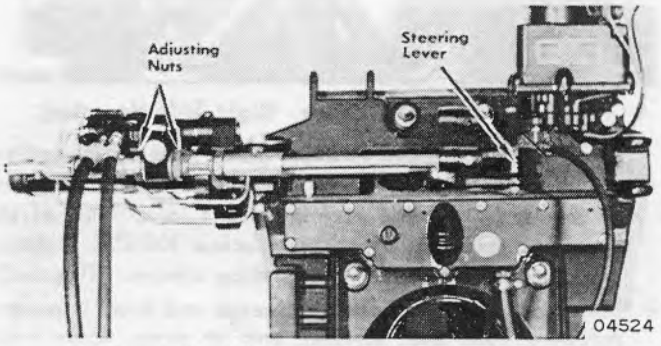


Figure 8. Adjusting Cable Guide Tube - Right Side Mounting

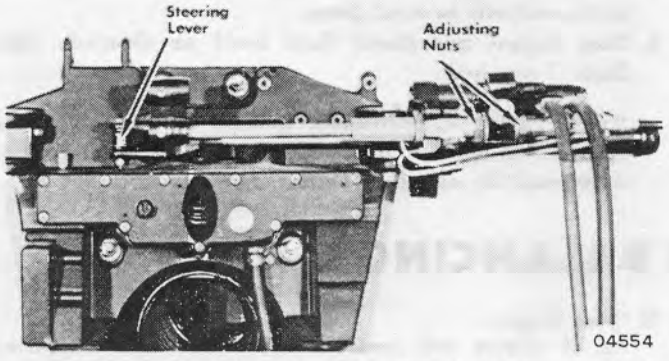


Figure 9. Adjusting Cable Guide Tube - Left Side Mounting

3. Turn steering wheel counterclockwise for right side mounted (clockwise for left side mounted) and position adjusting sleeve on cable guide tube by loosening jam nut and turning sleeve, as required, so that steering lever is at end of its travel and pressure on gauge is below 100 PSI. Tighten jam nut securely against adjusting sleeve. (Figure 10 or 11)
4. Position tubular slide on cable guide tube, as shown in Figure 10 or 11, to protect threads on tube.
5. Stop engine. Remove pressure gauge and hose. Connect pressure hose from steering unit to pump. Make connections as quickly as possible to prevent fluid from draining out of hose and pump.

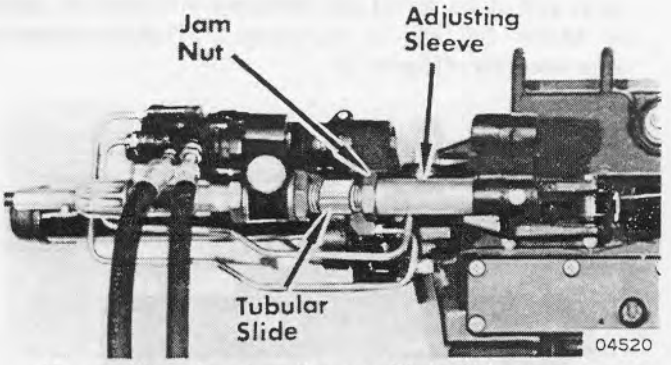


Figure 10. Adjusting Sleeve - Right Side Mounting

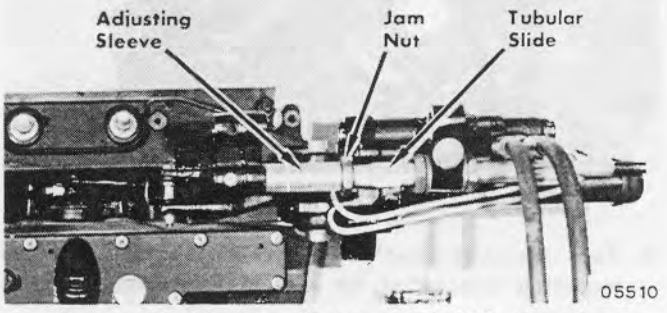


Figure 11. Adjusting Sleeve - Left Side Mounting

6. Start engine and run at idle speed. Turn steering wheel back-and-forth several times.
7. Stop engine and check fluid level on dipstick. Add fluid if required.

NOTE: After reinstallation, if more steering effort is required in one direction than in the other, the control valve must be adjusted (balanced).

POWER STEERING for 215 ENGINE

ADJUSTING STEERING

1. Start engine and run at 600-700 RPM in neutral gear.

   IMPORTANT: Do not operate engine without cooling water flowing thru water pickup pump.

2. Turn steering wheel clockwise for right side mounting (counterclockwise for left side mounting) and adjust cable guide tube position on steering unit (by loosening adjusting nuts and moving tube) so that steering wheel gear rack is at end of its travel, steering lever is at end of its travel and pressure indicated on gauge is below 100 PSI (7 kg/sq.cm.). Tighten adjusting nuts securely. (Figure 1)

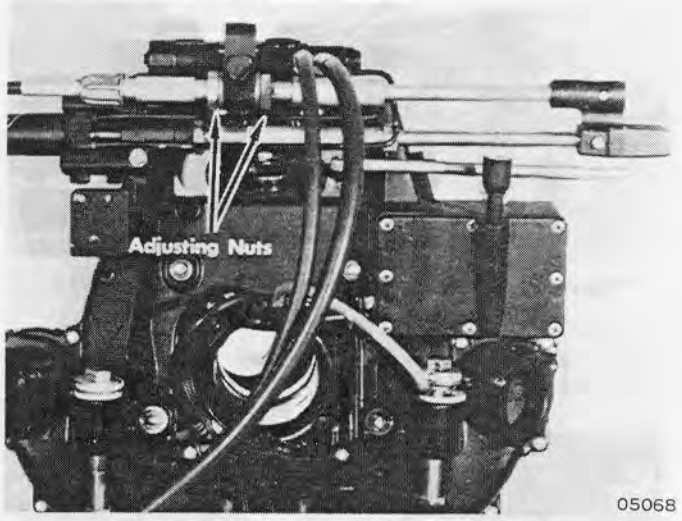


Figure 1. Adjusting Cable Guide Tube

3. Turn steering wheel counterclockwise for right side mounting (clockwise for left side mounting) and position adjusting sleeve on cable guide tube by loosening jam nut and turning sleeve against cable end adaptor, as required, so that steering lever is at end of its travel and pressure on gauge is below 100 PSI. Tighten jam nut securely against adjusting sleeve. (Figure 2)

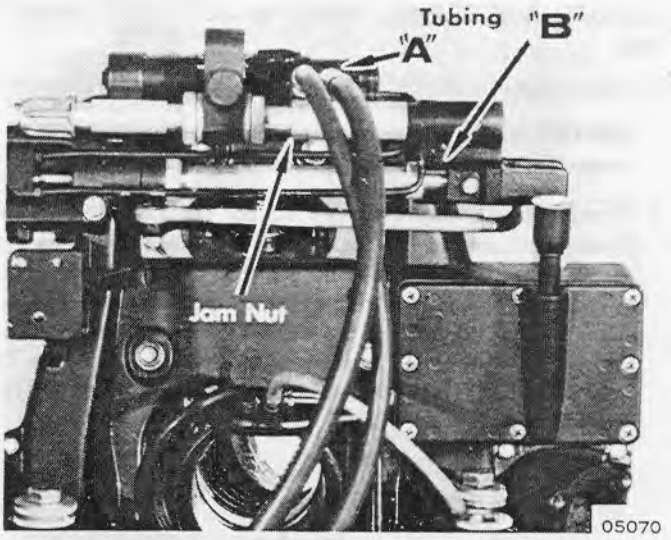


Figure 2. Adjusting Sleeve - Right Side Mounting

4. Stop engine. Remove pressure gauge and hose. Connect pressure hose from steering unit to pump. Make connections as quickly as possible to prevent fluid from draining out of hose and pump.
5. Start engine and run at idle speed. Turn steering wheel back-and-forth several times.
6. Stop engine and check fluid level on dipstick. Add fluid if required.

NOTE: After reinstallation, if more steering effort is required in one direction than in the other, the control valve must be adjusted (balanced).

CONTROL VALVE BALANCING

Figure 5. Removing Adjusting Nut

1. Detach valve and adaptor from Power Steering input cable. According to Figures 6-7-8, remove dust cover.
2. Check system hoses and fill pump reservoir to proper level.

IMPORTANT: Do not operate engine without cooling water flowing thru water pickup pump, or pump will be damaged. Engine may be operated with boat out of water, if instructions, outlined under "Flushing" in "Operation and Maintenance Manual", are followed.

3. Start Engine
   a. If piston rod remains retracted, turn adjusting nut (Figure 5) clockwise until valve assembly begins to extend, then turn nut counterclockwise until rod just begins to retract. Now turn nut clockwise to exactly one-half the rotation needed to change direction of piston rod movement.
   b. If piston rod extends, turn adjusting nut (Figure 5) counterclockwise until valve assembly begins to retract, then turn nut clockwise until rod just begins to extend. Now turn nut counterclockwise to exactly one-half the rotation needed to change direction of piston and movement.

NOTE: Do not move adjusting nut more than necessary to retain its friction locking quality.

CAUTION: Use care when turning adjusting nut. Use long extension shaft(s) on socket when turning adjusting nut and BE CAREFUL not to place hands in a position where they could be injured by movement of steering components.

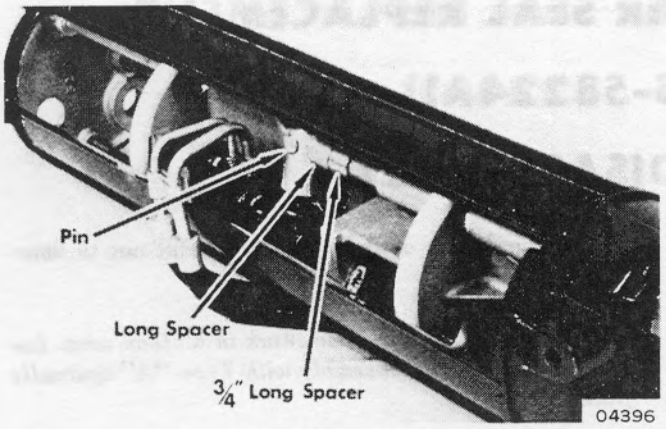


Figure 6. Steering Cylinder

4. When valve is balanced, valve assembly may be moved manually to activate cylinder.
5. Turn off engine. Reinstall input cable and complete reinstallation.
6. Restart engine. If valve assembly does not move in either direction, valve adjustment is correct. If not, rebalance valve.
7. Stop engine after valve is adjusted. Place Multipurpose Lubricant (C-92-49588) on end of valve and install dust cap.

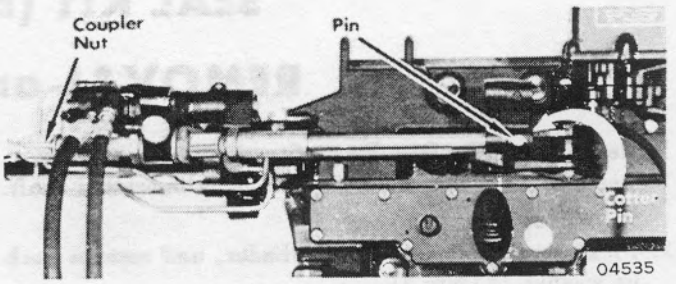


Figure 7. Steering Cylinder - MerCruiser III

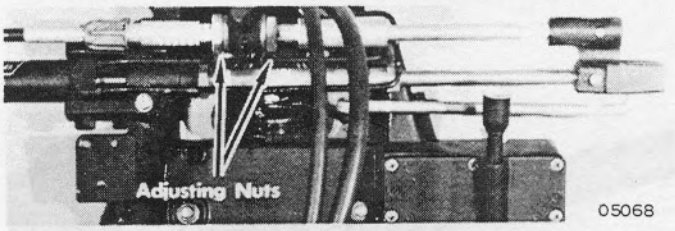


Figure 8. Steering Cylinder - MerCruiser 215

POWER STEERING CYLINDER SEAL REPLACEMENT

SEAL KIT (B-25-58224A1)

REMOVAL and DISASSEMBLY

1. Remove cylinder from Power Steering assembly.
2. Remove snap ring and scraper from cylinder and shaft. (Figure 1)
3. Pick scraper element from cylinder, and remove back-up washer. (Figure 2)
4. Pry oil seal from cylinder, being careful not to damage cylinder.

NOTE: Keep all parts clean. Work in a clean area. Lubricate parts during assembly with Type "A" hydraulic fluid.

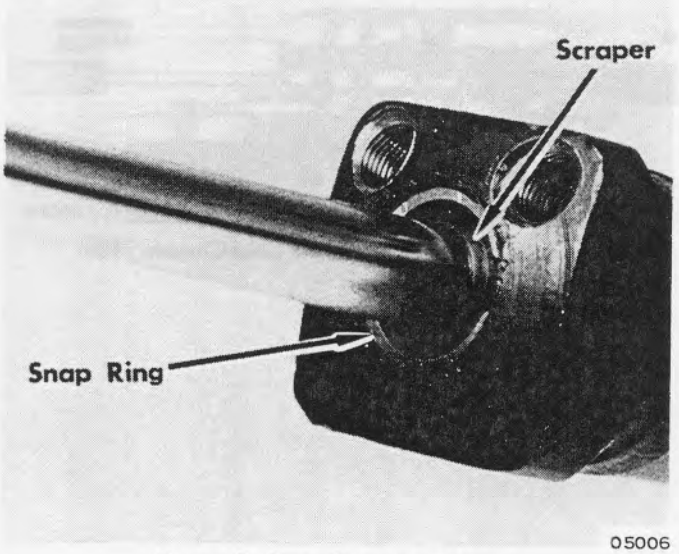


Figure 1. Snap Ring Location

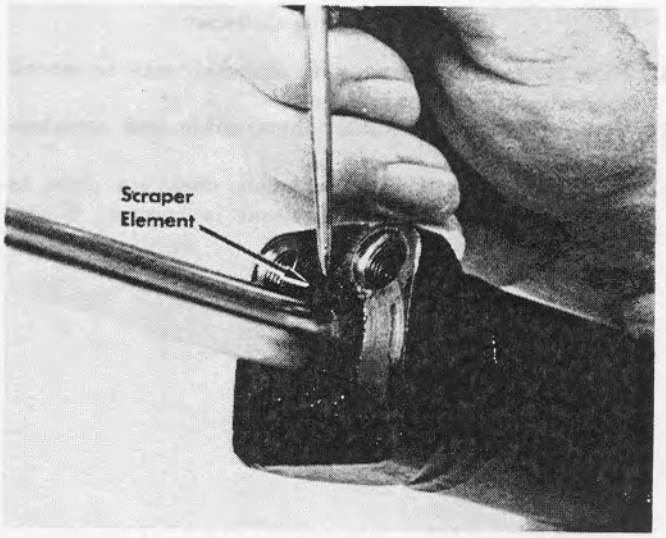


Figure 2. Removing Scraper Element

REASSEMBLY

1. Press in new oil seal (lip in toward cylinder) with backing washer and appropriate mandrel. (Figure 3)
2. Place new scraper element with bevel toward cylinder and new scraper with bevel outward from cylinder.
3. Install new snap ring and reassemble cylinder in Power Steering assembly.

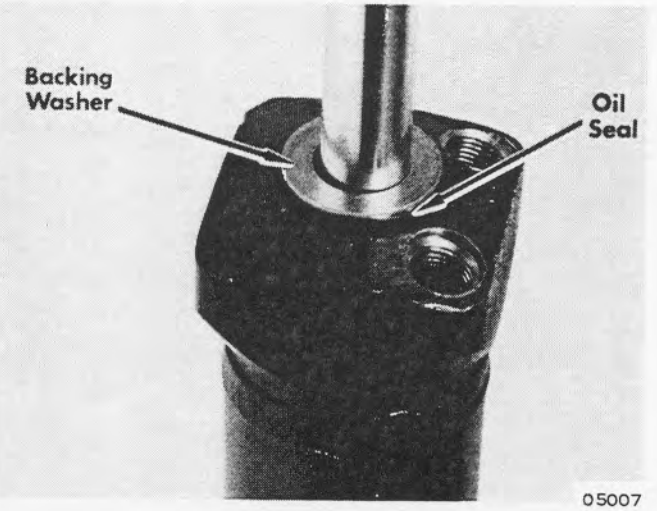


Figure 3. Installing Oil Seal

CONTROL VALVE NUT and SEAL KIT

(C-25-58226A1)

REMOVAL and DISASSEMBLY

1. Remove control valve and adaptor from Power Steering unit.
2. Place control valve in a vise and remove dust cover. (Figure 4)
3. Count and note turns required to remove adjusting nut and washer. (Figure 5) Remove valve housing to adaptor screws. (Figure 5)
4. Lift valve housing from adaptor and remove valve spool from housing.
5. Remove valve parts from valve shaft. (Figure 6)

Do Not Disassemble Adaptor.

NOTE: Keep all parts clean. Work in a clean area. Lubricate parts during assembly with Type "A" hydraulic fluid.

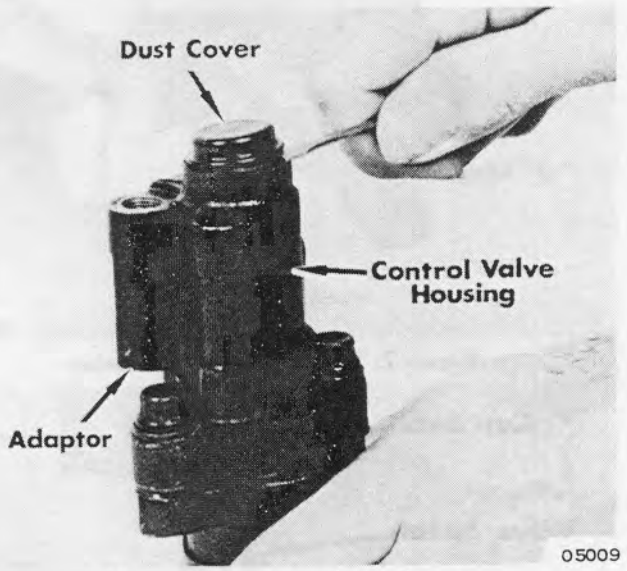


Figure 4. Removing Dust Cover

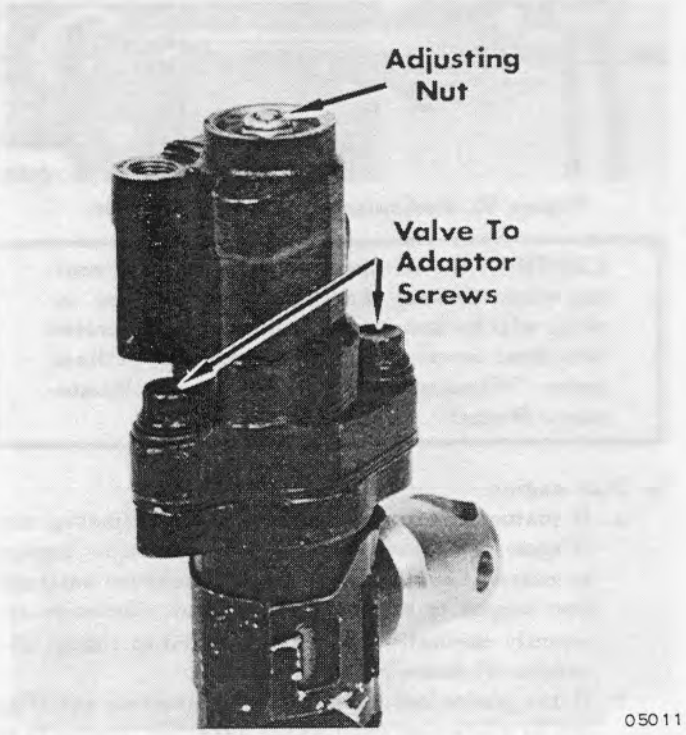


Figure 5. Valve Housing Screw Removal

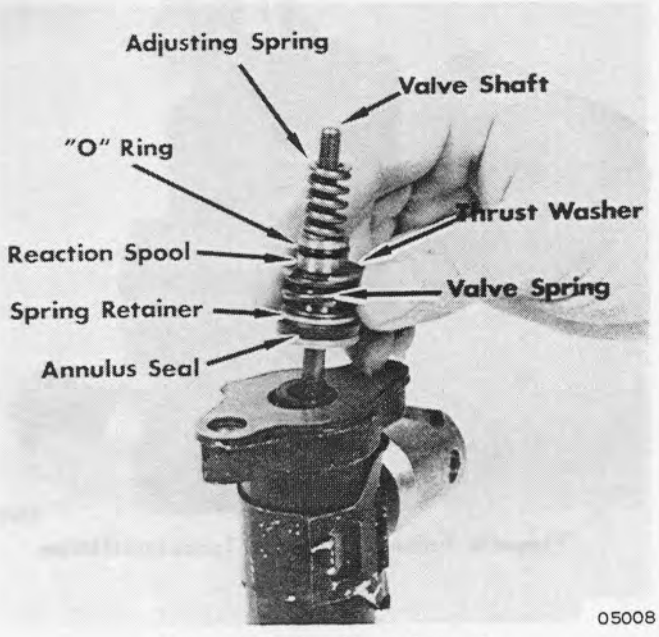


Figure 6. Valve Parts Location

REASSEMBLY

1. Install a new "O" ring on reaction spool. (Figure 6)
2. Install a new annulus seal with valve parts and reposition on valve shaft. (Figure 6)
3. Carefully reinstall valve housing with new "O" ring over valve shaft and tighten screws securely. (Figure 7)
4. Install new cup seal (lip inward) on valve spool and carefully insert spool into valve housing. (Figure 8)
5. Install new adjusting nut with washer on valve shaft the same number of turns required to remove nut from valve shaft (Step 3 in "Disassembly", preceding).
6. Reinstall dust cover and control valve in Power Steering unit.

NOTE: If, after reinstallation, greater steering effort is required in one direction than the other, the control valve must be adjusted (balanced).

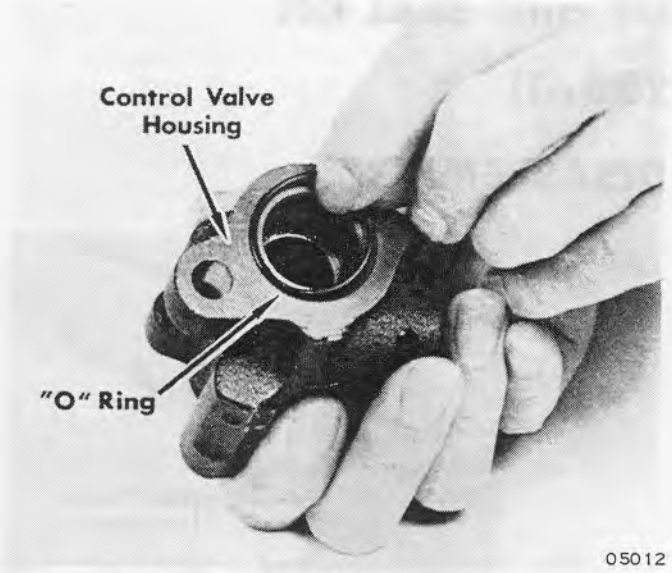


Figure 7. Valve "O" Ring Location

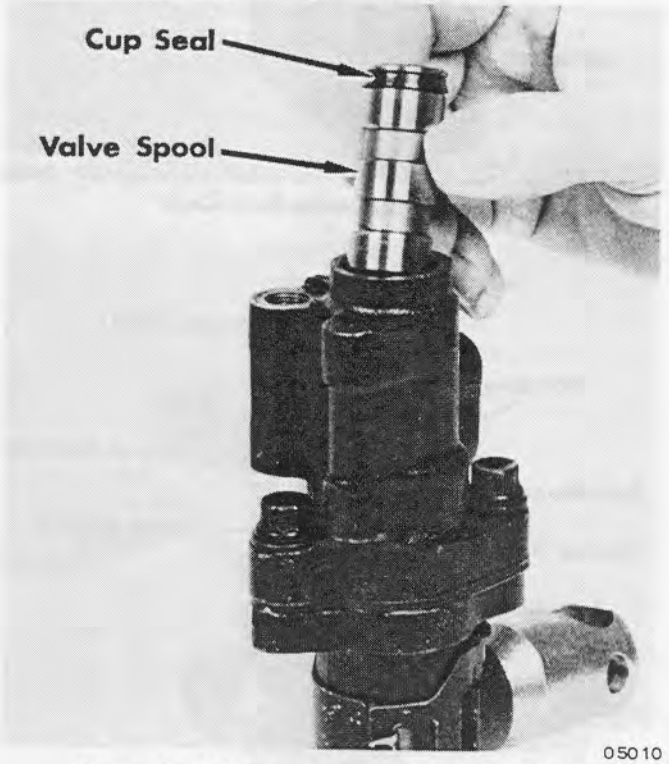


Figure 8. Valve Housing and Spool Installation

VALVE BALANCING

1. Detach valve and adaptor from Power Steering input cable, according to Figures 9-10-11, and remove dust cover. (Figure 4)
2. Check system hoses and fill pump reservoir to proper level.

IMPORTANT: Area behind and in front of steering unit must not contain any obstruction which will prevent steering unit from pivoting. If steering unit cannot pivot freely, cylinder or piston rod will be damaged.

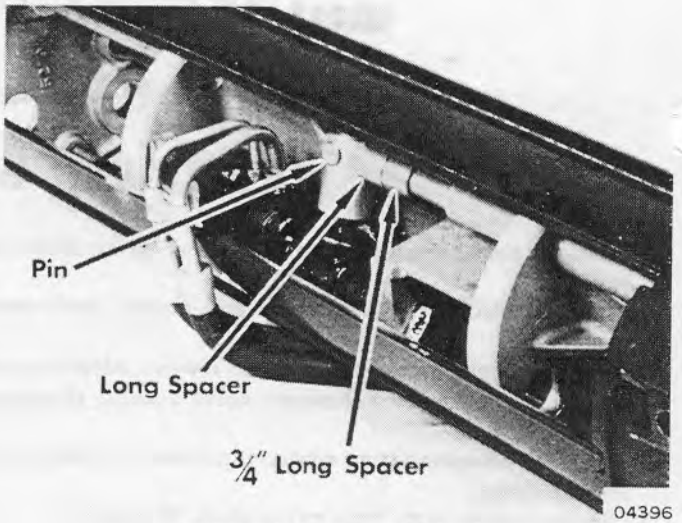


Figure 9. Steering Cylinder

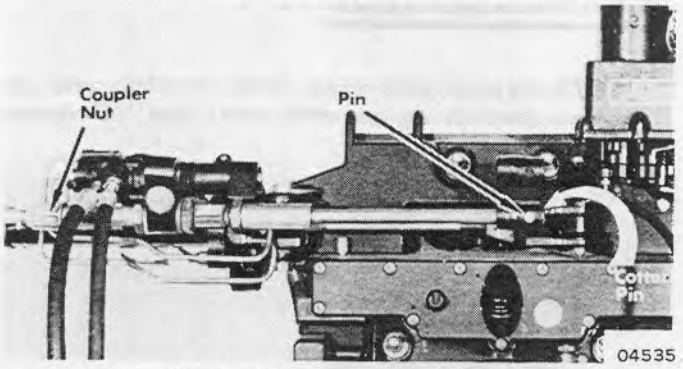


Figure 10. MerCruiser III Steering Cylinder

CAUTION: Do not operate engine without cooling water flowing thru water pickup pump, or pump will be damaged. Engine may be operated with boat out-of-water, if instructions, outlined under "Flushing" in "Operation and Maintenance Manual", are followed.

3. Start engine
   a. If piston rod remains retracted, turn adjusting nut (Figure 5) clockwise until valve assembly begins to extend, then turn nut counterclockwise until rod just begins to retract. Now turn nut clockwise to exactly one-half the rotation needed to change direction of piston rod movement.
   b. If the piston rod extends, turn adjusting nut (Figure 5) clockwise until valve assembly begins to retract. Turn nut clockwise until rod just begins to extend. Turn nut counterclockwise to exactly one-half the rotation needed to change direction of piston and movement.

NOTE: Do not move adjusting nut more than necessary (to retain its friction locking quality).

CAUTION: Use care when turning adjusting nut. Use long extension shaft(s) on socket when turning adjusting nut and do not place hands in a position where they could be injured by valve movement.

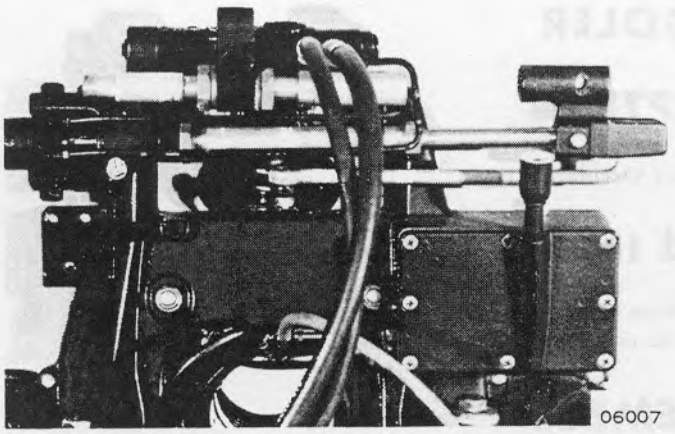


Figure 11. MerCruiser 215 Steering Cylinder

4. When valve is balanced, valve and cylinder assembly may be moved in or out manually.

FUNCTIONAL CHECK

1. With engine not running, reinstall input cable.
2. Restart engine. If valve assembly does not move in either direction, valve adjustment is correct. If not, readjust and rebalance valve.
3. Stop engine after valve is adjusted. Place New Multipurpose Lubricant (C-92-49588) on end of valve and install dust cap.

POWER STEERING "O" RING KIT (C-25-36324A1)

Power Steering Cylinder Repair

REMOVAL

NOTE: Keep all parts clean. Work in a clean area. Lubricate parts during assembly with Type "A" hydraulic fluid.

1. Disassemble Power Steering housings to remove valve housing assembly.
2. Remove 4 screws and end plate from valve housing.
3. Remove oil seal carrier and end bearing from shaft. (Figure 12)
4. Remove special seal and "O" ring from end bearing.

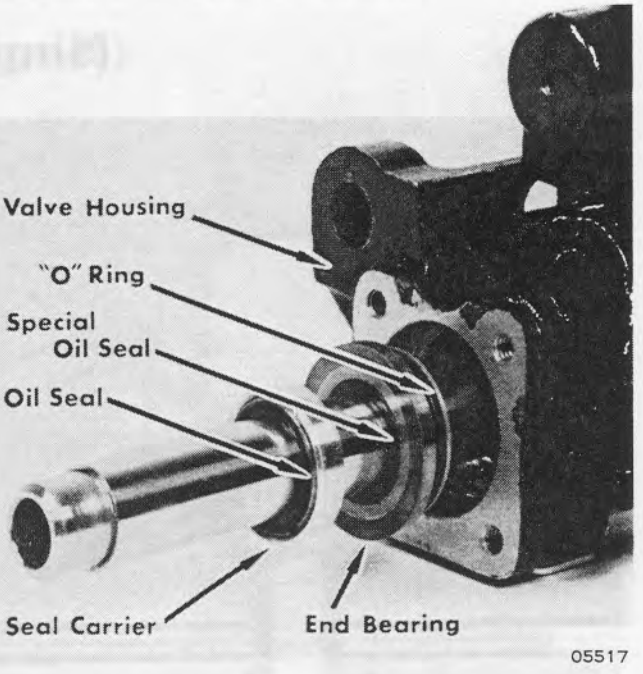


Figure 12. Components Exposed

REASSEMBLY

1. Place new "O" ring on end bearing and place on shaft.
2. Place special seal with spacers over shaft and gently position into end bearing.
3. Press new oil seal into new seal carrier supplied with kit.
4. Place seal carrier on shaft. Push on seal carrier and end bearing to position them in valve housing without disturbing the special oil seal.
5. Replace end plate and tighten screws securely. Repeat procedure on other end of valve housing to complete Power Steering cylinder repair.
6. Reassemble valve housing in Power Steering housing.

OIL COOLER

DESCRIPTION

The oil cooler is a water circulating type.

CLEANING and INSPECTION

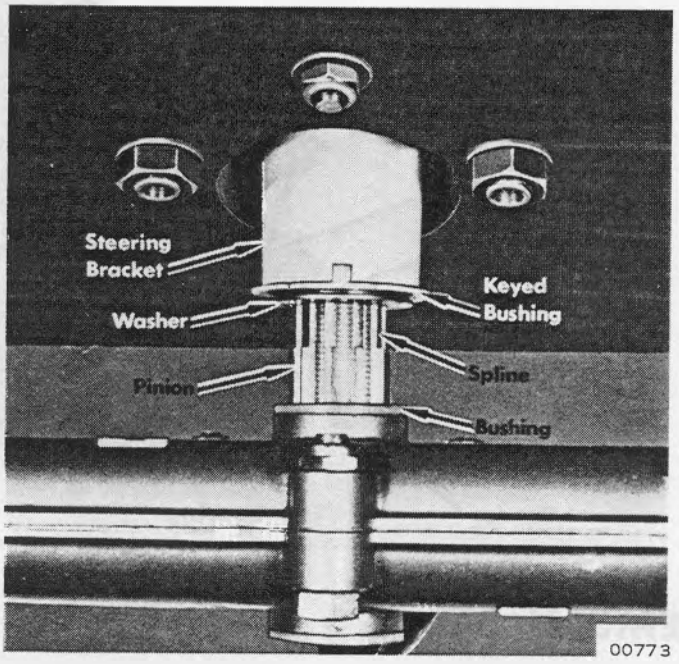
To clean oil cooler, remove oil cooler from engine and blow cooler out with compressed air. Also, a wire brush may be used to ream out the cooler tubes.

DISASSEMBLY

The oil cooler core cannot be disassembled. If oil cooler core is defective, replace entire oil cooler.

CAUTION: Oil coolers on MerCruiser engines and on Power Steering must be drained before cold weather storage. Remove drain plug and allow all water to drain out. Reinstall drain plug and tighten securely so that system will operate when engine is returned to service.

RIDE-GUIDE STEERING CABLE REPLACEMENT (Single or Super)



1. Remove cap. Remove locking nuts which hold cable end to rack.
2. Loosen nut which locks cable assembly to tube.
3. Thread cable from tube.
4. Remove thru bolt nut and washer.

   NOTE: Remove screws or bolts which hold gear rack to mounting bracket, if additional clearance is needed to remove cable.

5. Install new cable. Reassemble in reverse order of disassembly. Lubricate moving parts with New Multipurpose Lubricant (C-92-49588).

Figure 1. Pinion on Bottom

RIDE-GUIDE STEERING TROUBLESHOOTING

IMPORTANT: Check trim tab setting and adjust before troubleshooting Ride-Guide Steering System.

1. Disconnect cable from steering lever on stern drive and pull from Rid-Guide tube. Follow cable through boat, checking on proper length, kinks, etc.
2. Operate steering wheel to check for freedom. Readjust rack(s) and wheel(s) to reduce friction. Add more Multipurpose Lubricant (C-92-49588) to shaft, nylon bushings, rack(s) and pinion(s).

IMPORTANT: Complete the following steps only if steering problem cannot be corrected.

3. Lubricate steering cable through grease fitting on transom end of cable only when inner cable at transom end is fully retracted. If lubricating steering cable when extended, a hydraulic lock can result.

   NOTE: Cable is factory-lubricated and, therefore, requires additional lubrication with Multipurpose Lubricant only after extended use of 50 or more hours. If a new cable is thought to be the cause of hard steering, regreasing the cable probably will not improve performance. See "4", following.

4. Pull cable from boat and again check for kinks, damage, etc. Reinstall or replace cable.

ROTARY RIDE-GUIDE STEERING CABLE REPLACEMENT (Single or Super)

1. Remove thru bolt, stop nut and washer.
2. Remove slide gear and pinion housing. (Figure 1)
3. Separate housing halves to remove cable.
4. Install new cable. Reassemble in reverse order of disassembly.

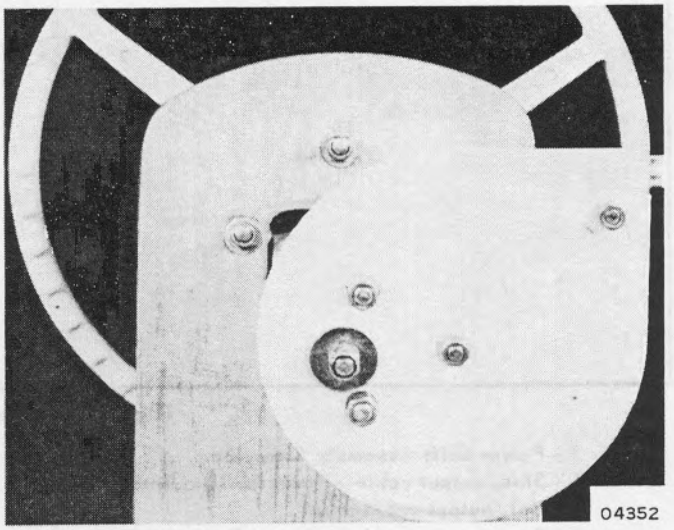


Figure 2. Steering Wheel Mounted

POWER SHIFT

DESCRIPTION

The Power Shift cylinder is a vacuum-actuated cylinder which is used to assist the mechanical shifting. The vacuum is produced in the intake manifold, then is piped to the shift cylinder thru hoses.

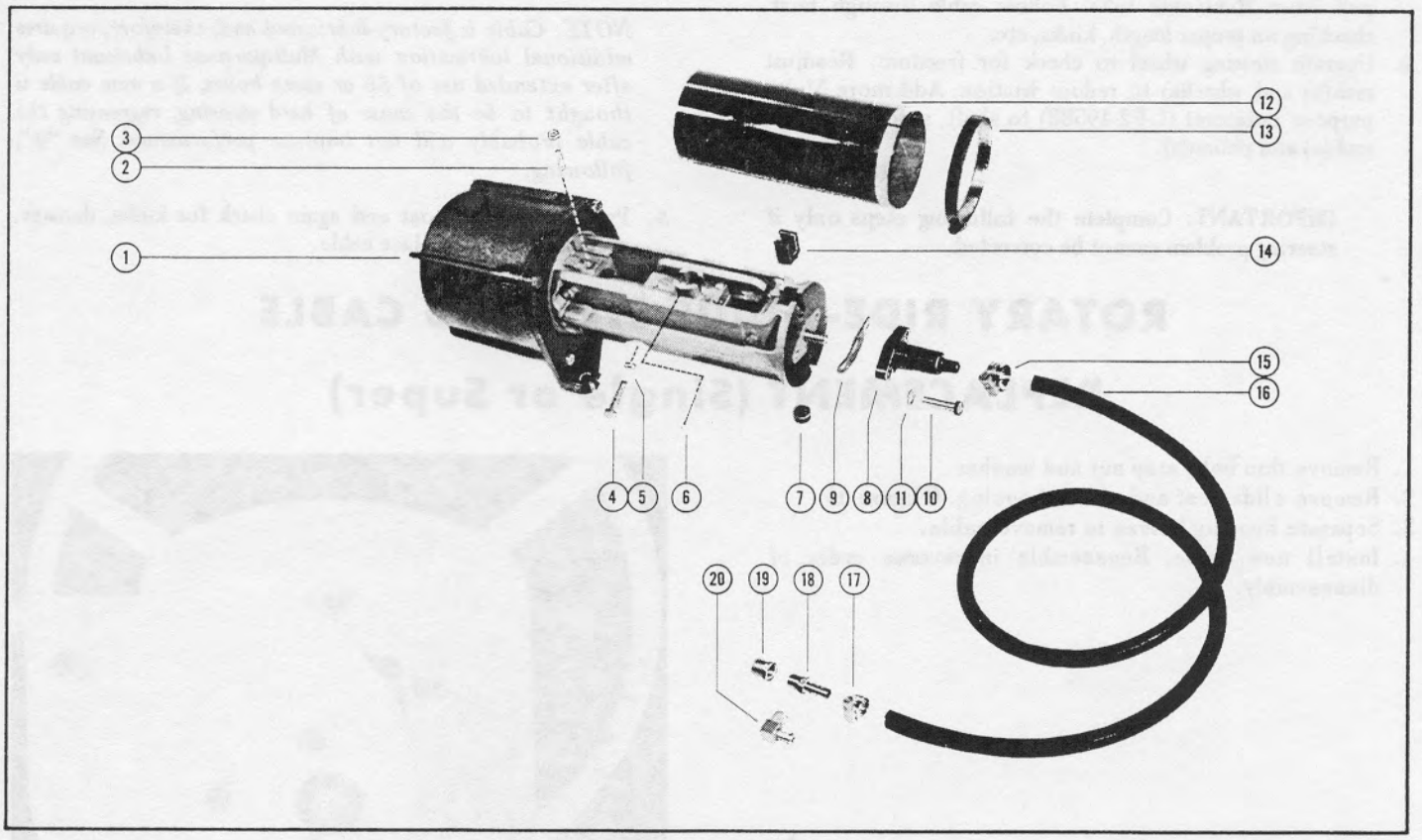
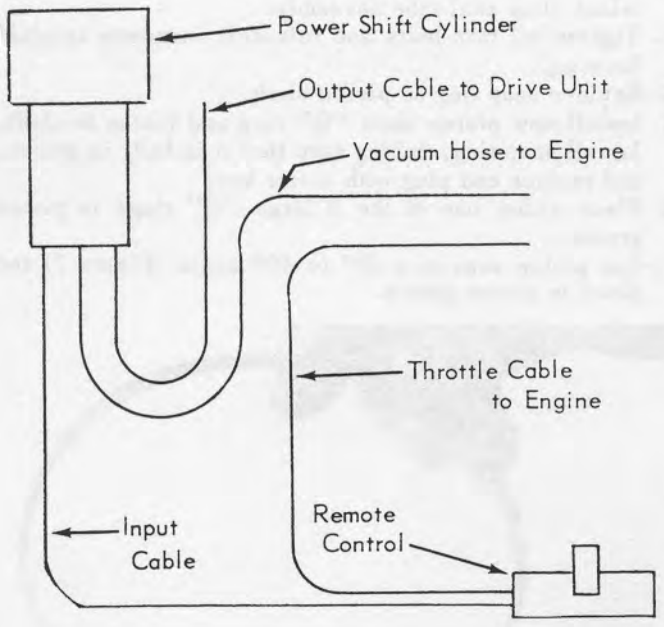


Figure 1. Power Shift, Exploded View

1 - Power Shift Assembly Complete
2 - Stud, output cable - Power Shift cylinder
3 - Nut, output cable stud
4 - Screw, input cable to Power Shift cylinder
5 - Nut, input cable screw
6 - Cotter pin, output cable to Power Shift cylinder
7 - Plug, felt - Power Shift cylinder
8 - Flange, inlet - Power Shift cylinder
9 - Gasket, inlet flange
10 - Screw, inlet flange to Power Shift cylinder
11 - Lockwasher, inlet flange screw
12 - Dust Shield, Power Shift cylinder
13 - Clamp, dust shield to Power Shift cylinder
14 - Spacer, felt - Power Shift cylinder
15 - Clamp, vacuum hose to Power Shift cylinder
16 - Hose, vacuum - Power Shift cylinder to engine
17 - Clamp, vacuum hose to engine fitting
18 - Fitting, vacuum hose
19 - Bushing, reducer - vacuum hose fitting
20 - Connector, vacuum hose

TROUBLESHOOTING



If the Power Shift system does not operate properly, proceed with the following:

a. System does not react
   1. With engine running, check vacuum hose and shift cylinder for vacuum leaks.
   2. Check for proper installation.

b. System binds
   1. Disconnect output cable from shift arm. With engine running, operate remote control. If output cable operates without binding and with sufficient force, adjust shift cables. If control binding occurs, proceed to Step 2.
   2. Stop engine. Disconnect input cable from Power Shift cylinder. Operate remote control. If control binds, check input control cable adjustment and remote control box. If control input cable adjustment and remote control box are good, repair Power Shift cylinder with repair kit, following.

Figure 2. Typical Power Shift Installation Diagram

POWER SHIFT CYLINDER REPAIR KIT (C-25-36125A2)

For Power Shift Assemblies (C-35718A2 and B-38638A2)

REMOVAL, DISASSEMBLY and REASSEMBLY

1. Remove cylinder. (Figure 3)
2. Remove piston seal and "O" ring from piston. (Figure 4)

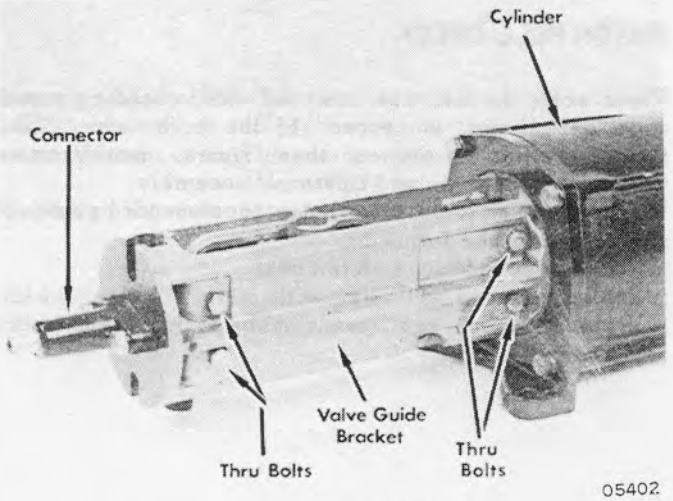


Figure 3. Power Shift Cylinder

3. Remove cotter pin and shaft end plug. Replace "O" ring on shaft end plug. (Figure 5)
4. Remove snap ring to remove piston and piston shaft "O" ring.

NOTE: Piston shaft "O" ring may not be present.

5. Remove second snap ring from piston shaft.
6. Remove 2 screws with copper sealing washers and 2 thru bolts (Figures 3 and 5) which hold end housing to valve guide brackets.
7. Slip assembly from shaft.
8. Drive out old seals from end housing and install new seals with lips facing out.

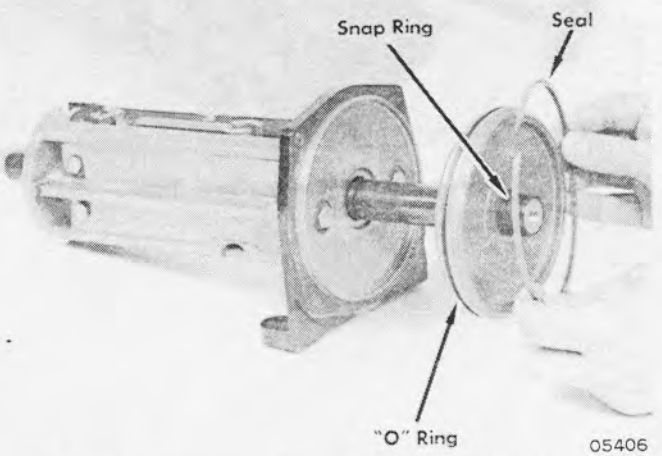


Figure 4. Removing Piston Seal and "O" Ring

9. Place a liberal coat of grease on piston shaft. Replace end housing over shaft, using shim stock to protect seals during reinstallation.

IMPORTANT: Use liberal coat of New Multipurpose Lubricant (C-92-49588) on seals and shafts during reassembly.

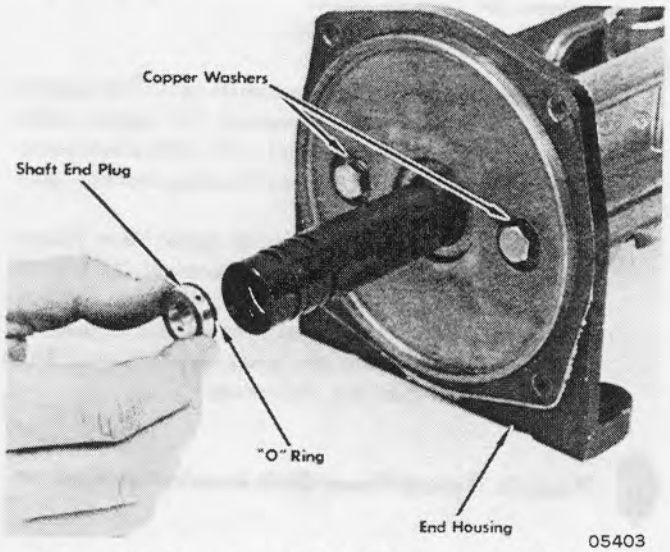


Figure 5. Removing Shaft End Plug and "O" Ring

10. Replace end housing with 2 screws, copper sealing washers and 2 thru bolts. Leave thru bolts loose temporarily.
11. Remove connector end from valve guide brackets and loosen 2 thru bolts. (Figure 3) Remove seal tube assembly and drive out old seal. Press in new seal with lip out. (Figure 6)

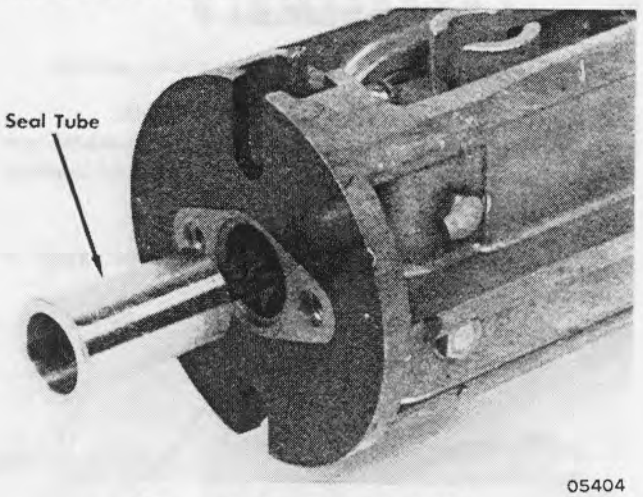


Figure 6. Removing Seal Tube

12. Use shim stock over tube end to protect seal when reinstalling seal tube assembly.
13. Tighten all thru bolts and reinstall connector to slide housing.
14. Replace snap ring on piston shaft.
15. Install new piston shaft "O" ring and piston to shaft. Install snap ring, making sure that it is fully in groove, and replace end plug with cotter key.
16. Place either one of the 2 large "O" rings in piston groove.
17. Cut piston seal at a 30° to 40° angle (Figure 7) and place in piston groove.

Figure 7. Cutting Piston Seal

18. Reinstall cylinder with new gasket and hold it in position with 2 screws while checking piston pull, following.

NOTE: Use grease as a gasket sealer.

PISTON PULL CHECK

Place scale on rack yoke and pull while reading pounds of pull. Pull must not exceed 15 lbs. or be under 5 lbs. If scale reading is between these figures, install remaining 2 cylinder screws and tighten all securely.
If scale reading is above or below recommended pounds of pull, complete the following:

1. Remove cylinder and piston seal.
2. Replace piston "O" ring with other "O" ring in kit.
3. Replace piston seal, reassemble cylinder and check piston pull.

SHIFT CABLE REPLACEMENT and ADJUSTMENT

1. Place remote control handle in neutral position.
2. Thread barrel on end of input shift cable so that center line of hole in barrel is 7-1/16" (17.94cm) from center of hole in end guide. (Figure 8)

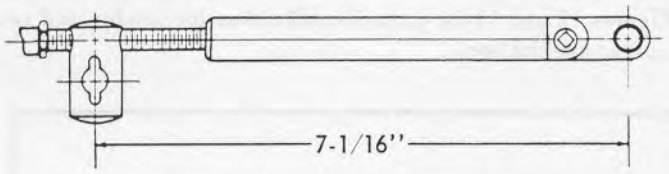


Figure 8. Input Cable Brass Barrel Location

3. Place barrel on input cable in valve guide bracket.
4. Fasten end guide to input cable bracket with screw and nut. (Figure 9)

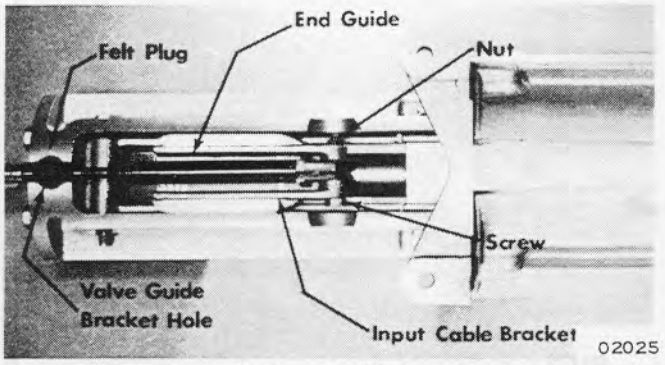


Figure 9. Input Cable Installed

5. Place end of output cable on stud and place barrel in yoke recess. (Figure 10)
6. Reinstall cotter pin & nut. Back off nut ½-turn. (Fig. 8)
7. Place felt spacer in recess and reinstall round felt plug. (Figure 8)

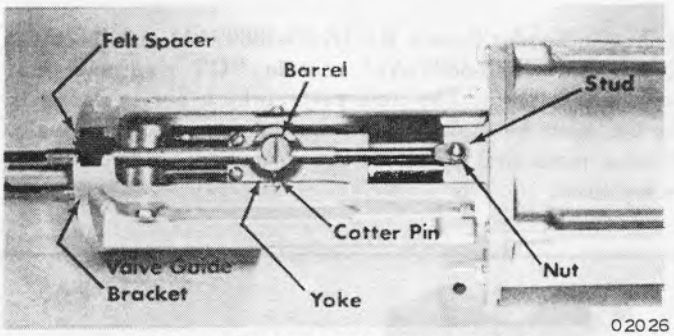


Figure 10. Output Cable Installed

8. Reinstall dust cover and position slot on the bottom. Replace clamp.

IMPORTANT: Do not fasten output cable to boat in any way. Outer conduit of cable must be free to move back and forth when unit is shifted.

NOTE: Hose clamp must be tight over inlet flange and intake manifold fitting. (Figure 11)

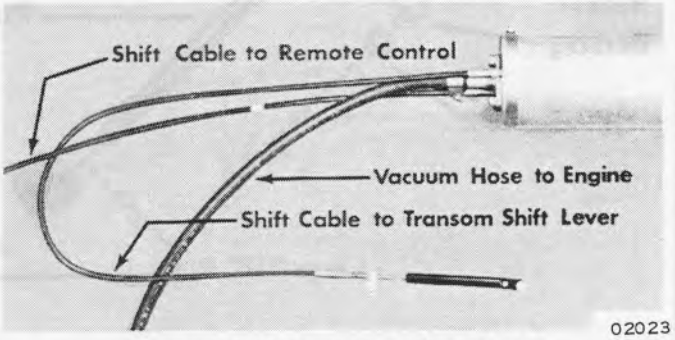


Figure 11. Vacuum Hose Connected

ATTACHING OUTPUT SHIFT CABLE to STERN DRIVE UNIT

Refer to Stern Drive Unit Installation Manual or Installation Section of MerCruiser Service Manual and follow procedure outlined for attaching and adjusting shift cable.

IMPORTANT

- Do not install propeller for attaching and adjusting shift cable.
- Do not attach throttle cable to carburetor before attaching and adjusting shift cable.
- Engine must be running and Power Shift operating when cable adjustment procedure calls for remote control handle to be moved to full forward or full reverse positions. After handle has been moved, engine may be stopped.
- Failure to comply with above instructions will result in improper unit shift cable adjustment and possible damage to stern drive shift mechanism.

HYDRAULIC SHIFT SENDER and RECEIVER REPAIR

Hydraulic Sender Repair Kit (B-25-38893A1) and Receiver Repair Kit (B-25-38894A1) contain "O" ring and seal replacement parts. The new parts, which are included in the kit, must be replaced as required for effective repair. If other parts are damaged, the complete assembly must be replaced.

Use only non-mineral automotive type hydraulic fluid SAE 70RI or 70R3 as a lubricant during repair and place parts on a clean surface.

DO NOT USE gasolines or thinners for cleaning. Refer to Figures 12 and 13 for parts identification for sender and receiver assemblies.

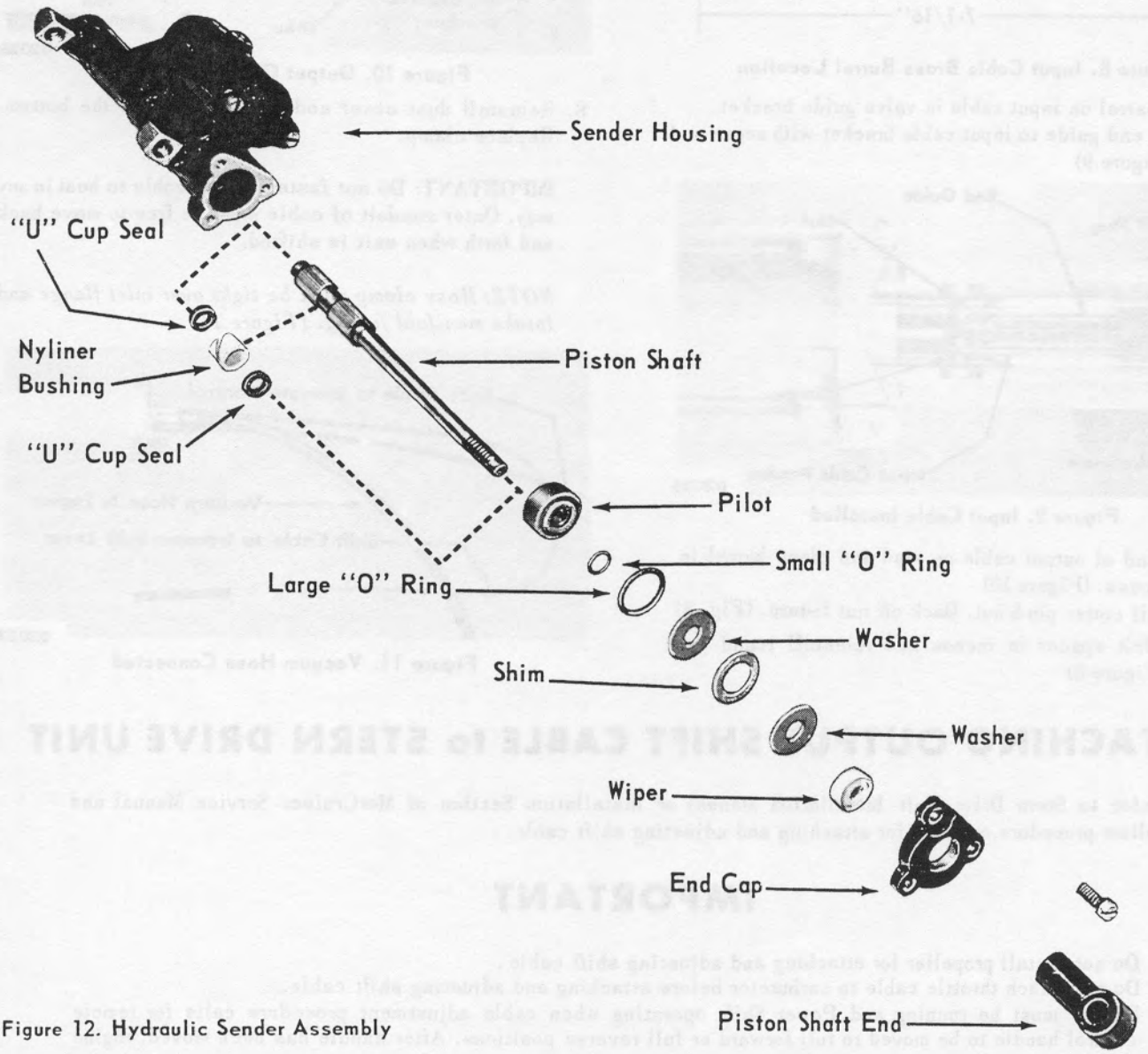


Figure 12. Hydraulic Sender Assembly

TESTING SENDER and RECEIVER

- If Not Leaking Externally and If Hydraulic Lines Are Not Broken or Leaking

1. Fill reservoir and place piston shaft in mid-stroke.
2. Place gasket washer under vent screw.
3. Remove hydraulic shift tubes and plug fittings with 7/16-24 inverted flare plugs.
4. Remove gasket washer under vent screw and apply constant inward pressure on piston shaft with shift lever. If piston shaft moves in and remains in, remove and repair.
5. Apply constant pull on piston shaft with shift lever.

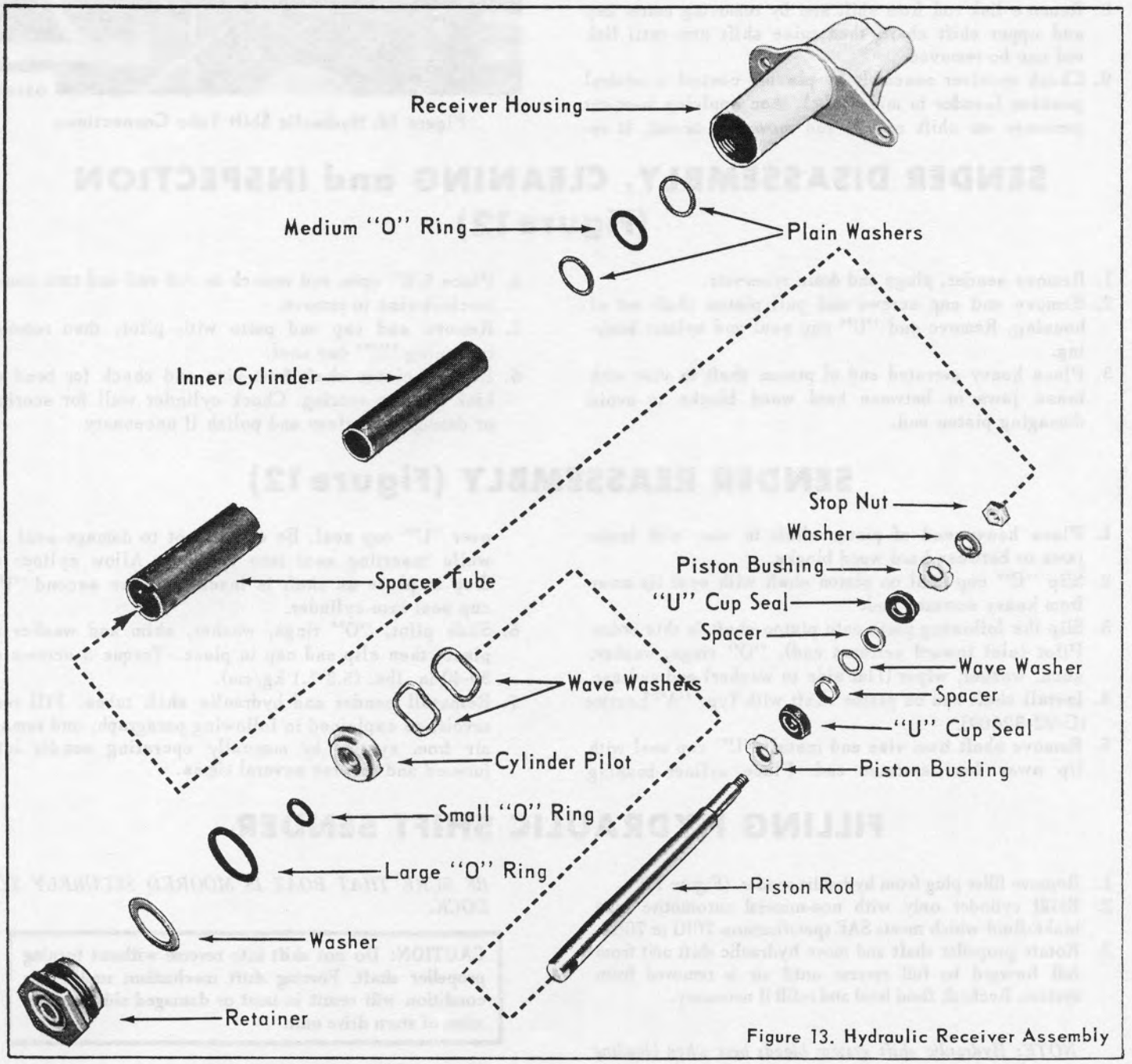


Figure 13. Hydraulic Receiver Assembly

If the shaft moves out and remains out, remove and repair. When piston rod is solid or returns to the original position, the sender is functioning properly, and the problem may be in the receiver assembly.

6. Remove plugs and reinstall hydraulic shift tubes. Fill reservoir and fully extend piston shaft.

NOTE: When installing hydraulic shift tubes on shift sender unit (mounted on inner transom plate assembly), attach long hydraulic tube to left inlet (looking "aft" from inside boat). Attach short tube to right inlet. (Figure 14) Attach short tube to upper inlet of shift receiver (located in bell housing) and long tube to lower inlet of shift receiver.

7. Remove drive shaft housing assembly. Reger to "Drive Shaft Housing, Disassembly", preceding.
8. Remove link rod from shift arm by removing cotter key and upper shift shaft, then raise shift arm until link rod can be removed.
9. Check receiver assembly by placing control in neutral position (sender in mid-stroke), then applying in-or-out pressure on shift rod. If rod moves in-or-out, it requires repair. When rod will not move in-or-out, or if it returns to its original position when released, it is not defective. Recheck hydraulic lines and sender, if nec-
10. Follow receiver repair procedure, following.

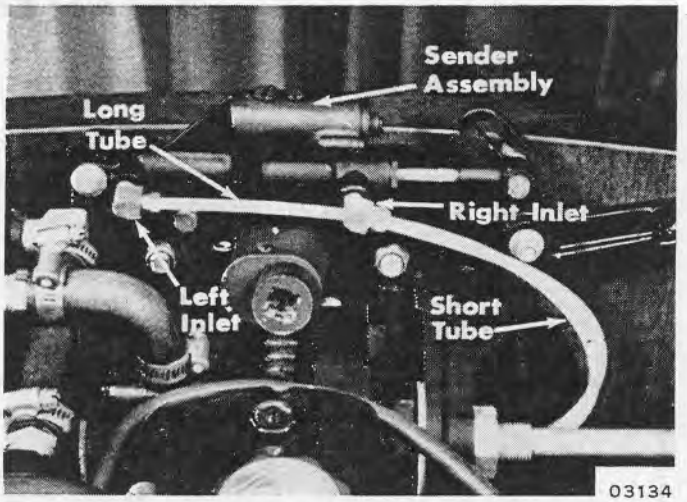


Figure 14. Hydraulic Shift Tube Connections

SENDER DISASSEMBLY, CLEANING and INSPECTION (Figure 12)

1. Remove sender, plugs and drain reservoir.
2. Remove end cap screws and pull piston shaft out of housing. Remove end "U" cup seal and nyliner bushing.
3. Place heavy serrated end of piston shaft in vise with brass jaws or between hard wood blocks to avoid damaging piston end.
4. Place 5/8" open end wrench on rod end and turn counterclockwise to remove.
5. Remove end cap and parts with pilot, then remove remaining "U" cup seal.
6. Remove piston shaft from vise and check for bend or kink and for scoring. Check cylinder wall for scoring or damage and clean and polish if necessary.

SENDER REASSEMBLY (Figure 12)

1. Place heavy end of piston shaft in vise with brass jaws or between hard wood blocks.
2. Slip "U" cup seal on piston shaft with seal lip away from heavy serrated end.
3. Slip the following parts onto piston shaft in this order: Pilot (slot toward serrated end), "O" rings, washer, shim, washer, wiper (flat side to washer) and end cap.
4. Install shaft end on piston shaft with Type "A" Loctite (C-92-32609).
5. Remove shaft from vise and install "U" cup seal with lip away from serrated end. Place nyliner bushing over "U" cup seal. Be careful not to damage seal lip while inserting seal into cylinder. Allow nyliner to drop in place as shaft is inserted. Ease second "U" cup seal into cylinder.
6. Slide pilot, "O" rings, washer, shim and washer in place, then slip end cap in place. Torque 3 screws to 30-40 in. lbs. (5.3-7.1 kg/cm).
7. Reinstall sender and hydraulic shift tubes. Fill reservoir, as explained in following paragraph, and remove air from system by manually operating sender into forward and reverse several times.

FILLING HYDRAULIC SHIFT SENDER

1. Remove filler plug from hydraulic sender. (Figure 15)
2. Refill cylinder only with non-mineral automotive type brake fluid which meets SAE specifications 70RI or 70R3.
3. Rotate propeller shaft and move hydraulic shift unit from full forward to full reverse until air is removed from system. Recheck fluid level and refill if necessary.

NOTE: Hydraulic shift system bleeds best when bleeding procedure is done with boat in water and motor running.

BE SURE THAT BOAT IS MOORED SECURELY TO DOCK.

CAUTION: Do not shift into reverse without turning propeller shaft. Forcing shift mechanism under this condition will result in bent or damaged shift mechanism of stern drive unit.

4. Reinstall filler plug.

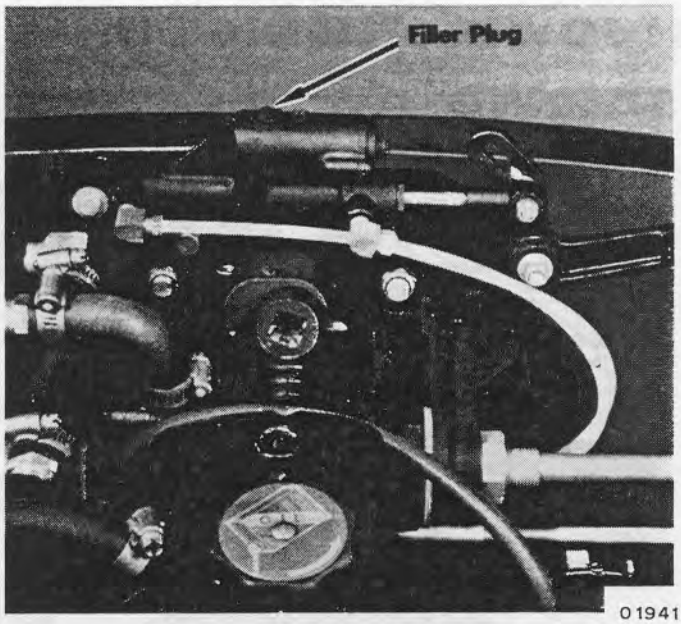


Figure 15. Shift Fluid Plug

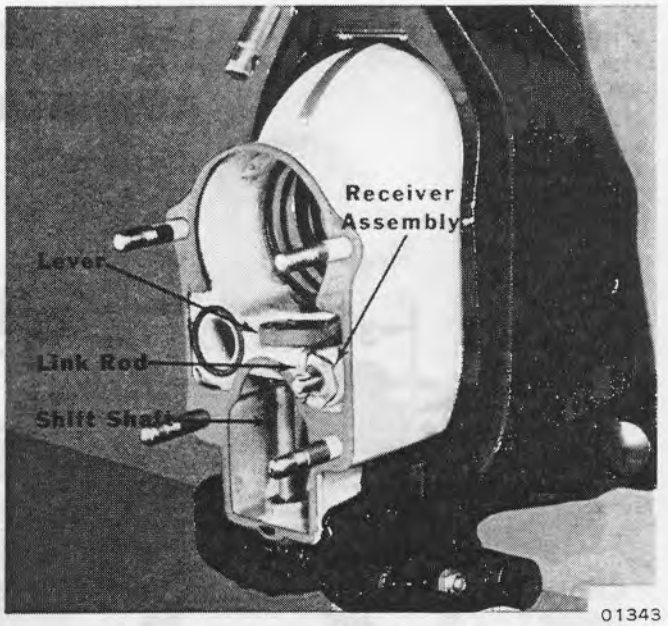


Figure 16. Receiver Unit Location with Drive Shaft Housing Removed

RECEIVER DISASSEMBLY, CLEANING and INSPECTION (Figure 13)

NOTE: Receiver may be repaired without removing from bell housing. (Figure 16)

1. Disconnect link rod from upper shift shaft lever assembly , if not already disconnected in Step No. 8, preceding.
2. Loosen retainer with 15/16" open end wrench and remove from housing, along with piston rod.
3. Remove remainder of internal parts with a wire hook.
4. Note-position of parts on shaft. Remove stop nut on rod end and all parts, including link rod.
5. Check piston rod for bend or kink and for scoring. Check cylinder wall for scoring or damage and clean and polish if necessary.

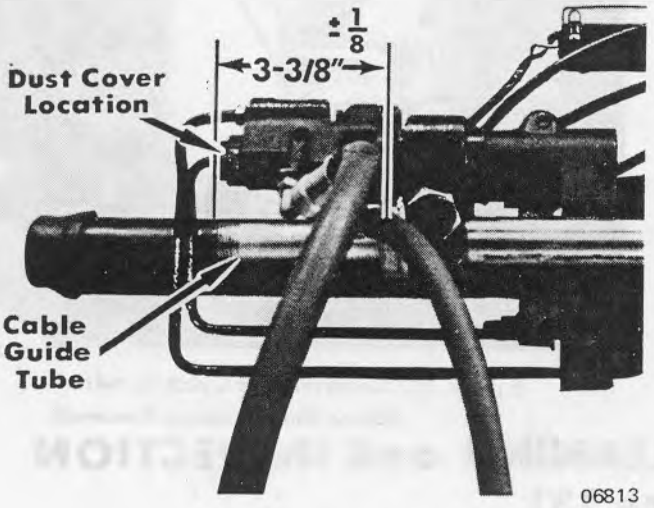
RECEIVER REASSEMBLY (Figure 13)

1. Attach link rod to piston rod and install the following parts in this order: Retainer, stainless steel washer, large and small "O" rings and cylinder pilot (slot away from retainer). (Figure 15)
2. Slip piston bushing on rod end with ejection marks (small circles) toward retainer. Install "U" cup seals lip-to-lip, with spacer, wave washer and spacer in between seals.
3. Install other piston bushing with ejection marks away from seal. Install washer and stop nut and tighten.
4. Carefully install inner cylinder over seals. Now mate the inner cylinder to cylinder pilot. Place 2 wave washers and spacer tube over inner cylinder.
5. Add a plain washer, "O" ring (medium size) and plain washer onto exposed end of inner cylinder.
6. Insert piston rod and parts into receiver housing. Hold onto piston rod and thread retainer clockwise with fingers, then use 15/16" open end wrench. If the retainer suddenly binds, repeat Steps 4 and 5.
7. When threads are almost covered by receiver housing, move piston rod in-and-out and continue to tighten retainer. If it begine to bind, back off slightly so that rod will move freely. No retainer threads should be exposed. If threads are exposed, repeat Steps 4, 5 and 6.
8. Install receiver, if removed. Fill sender reservoir and remove air from lines by manually operating sender into forward and reverse.
9. Reinstall link rod to shift shaft arm and upper shift shaft.
10. Reinstall drive shaft housing to bell housing, as explained previously.

MERCRUISER "PRE-ADJUSTED" POWER STEERING UNIT

ADJUSTING STEERING

Ride-Guide tube is pre-set at factory so that further adjusting of cable is not necessary. Should large nut and adaptor tube become loose, or pump lugging occurs when cable is fully extended from Ride-Guide tube, then dimension (shown in Figure 1 or 2) must be checked and corrected if necessary.



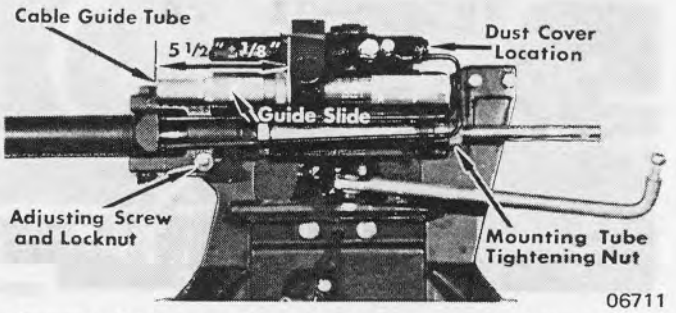


Figure 2. Ride-Guide Tube Dimension - 888-215-225 II-TR and 255 II-TR

Figure 1. Ride-Guide Tube Dimension - 110 thru 165 and MerCruiser III

CONTROL VALVE BALANCING

1. Detach steering input cable from valve and adaptor. Remove dust cover. (Figure 1 or 2)
2. Check system hoses and fill pump resevoir to proper level.

   IMPORTANT: Do not operate engine without cooling water flowing through water pickup pump(s).

3. Start engine, then -
   a. If piston rod remains retracted, turn adjusting nut (Figure 3) clockwise until piston rod begins to extend, then turn nut counterclockwise until rod just begins to retract. Now turn nut clockwise to exactly 1/2 the rotation needed to change direction of piston rod movement.
   b. If piston rod extends, turn adjusting nut (Figure 3) counterclockwise until piston rod begins to retract, then turn nut clockwise until rod just begins to extend. Now turn nut counterclockwise to exactly 1/2 the rotation needed to change direction of the piston rod movement.

   NOTE: DO NOT move adjusting nut more than necessary, so nut friction-locking quality is retained.

4. When valve is balanced, valve and cylinder assembly may be moved in-or-out manually.
5. Turn off engine. Reinstall input cable.
6. Restart engine. If cable end adaptor does not move in either direction, valve adjustment is correct. If not, rebalance valve.
7. Stop engine after valve is adjusted. Place Multipurpose Lubricant (C-92-49588) on end of valve and install dust cover.

CAUTION: Use care when turning adjusting nut. Use long extension shaft(s) on socket when turning adjusting nut and BE CAREFUL not to place hands in a position where they could be injured by cable adaptor movement.

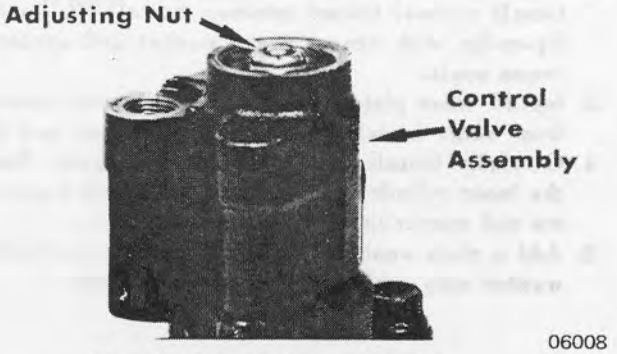


Figure 3. Adjusting Nut Location

SECTION 7 - ACCESSORIES

MERCRUISER

PART C - REMOTE CONTROLS

MERCURY MARINE

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REMOTE CONTROLS - MERCONTROL B-31621A1

SHIFT and THROTTLE CABLE REPLACEMENT

1. Remove 3 screws and separate control housing halves.
2. In removing left housing half, insert thumb into spline of drive gear to ensure that gear stays with right half.
3. Remove necessary retaining plates to remove control cable. (Figures 1, 2 and 3)

NOTE: Before installing control cables, make sure that square head set screws on nylon racks and end guides are tight.

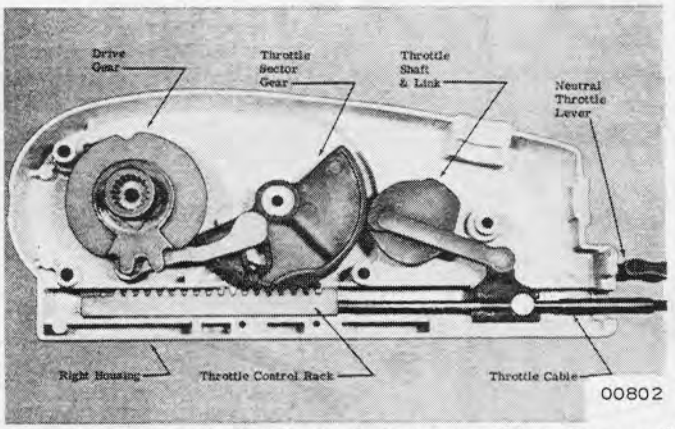


Figure 1. Throttle Cable Rack Retaining Plate Removed

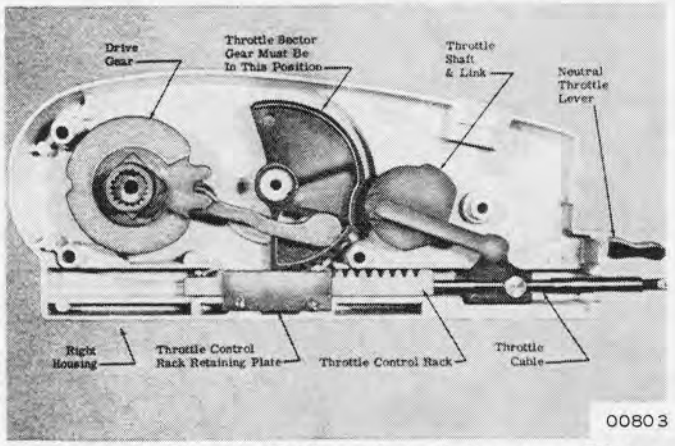


Figure 2. Throttle Cable with Rack Retaining Plate

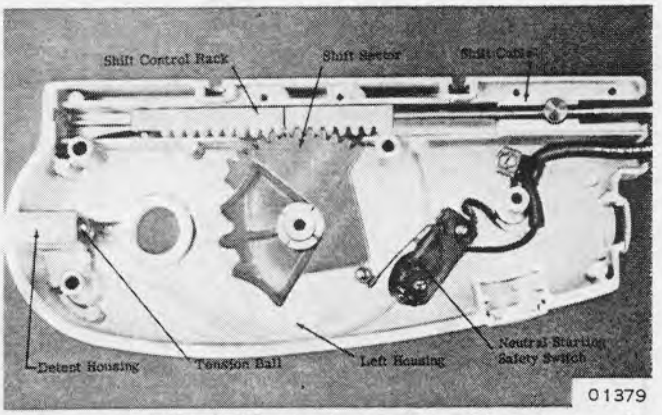


Figure 3. Shift Cable Rack Retaining Plate Removed

4. Lubricate all moving parts with Anti-Corrosion Grease (C-92-45134A1).
5. Set in full throttle position and engage last tooth of throttle sector in last tooth space of nylon rack. (Figure 1) Replace retaining plate.
6. Rotate throttle sector gear 90° to position shown in Figure 2.
7. Place alignment of gear shift rack in line with dot on tooth of gear shift sector. (Figure 3)
8. Move shift sector to position shown in Figure 4.
9. Replace rack and cable retaining plates.

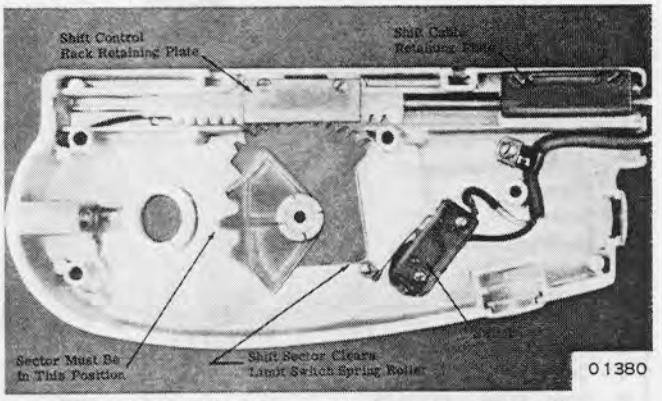


Figure 4. Shift Cable with Rack Retaining Plate

REASSEMBLY of CONTROL HOUSING (Figure 5)

1. Position plastic bushing in control housing, not on drive gear. Shift sector must clear limit switch spring roller, or it will bend spring when housings are assembled.
2. Reassemble housing halves.

NOTE: If housing halves do not fit together, sector gears are not meshing. Note position of sector gears in Figures 2 and 4. Place handle into splined recess and move gear sector slightly until gears mesh.

3. Set handle into splined end of drive gear on desired side and turn until detent (neutral position) is noted. Turn detent screw into desired control handle tension. (Figure 3)
4. Reposition control handle after control reassembly.

NOTE: If control handle of a shorter length is required to clear steering wheel, order handle No. C-30048.

ADJUSTMENT

Refer to "Removal-Installation-Alignment", Section 2, for shift and throttle cable adjustment.

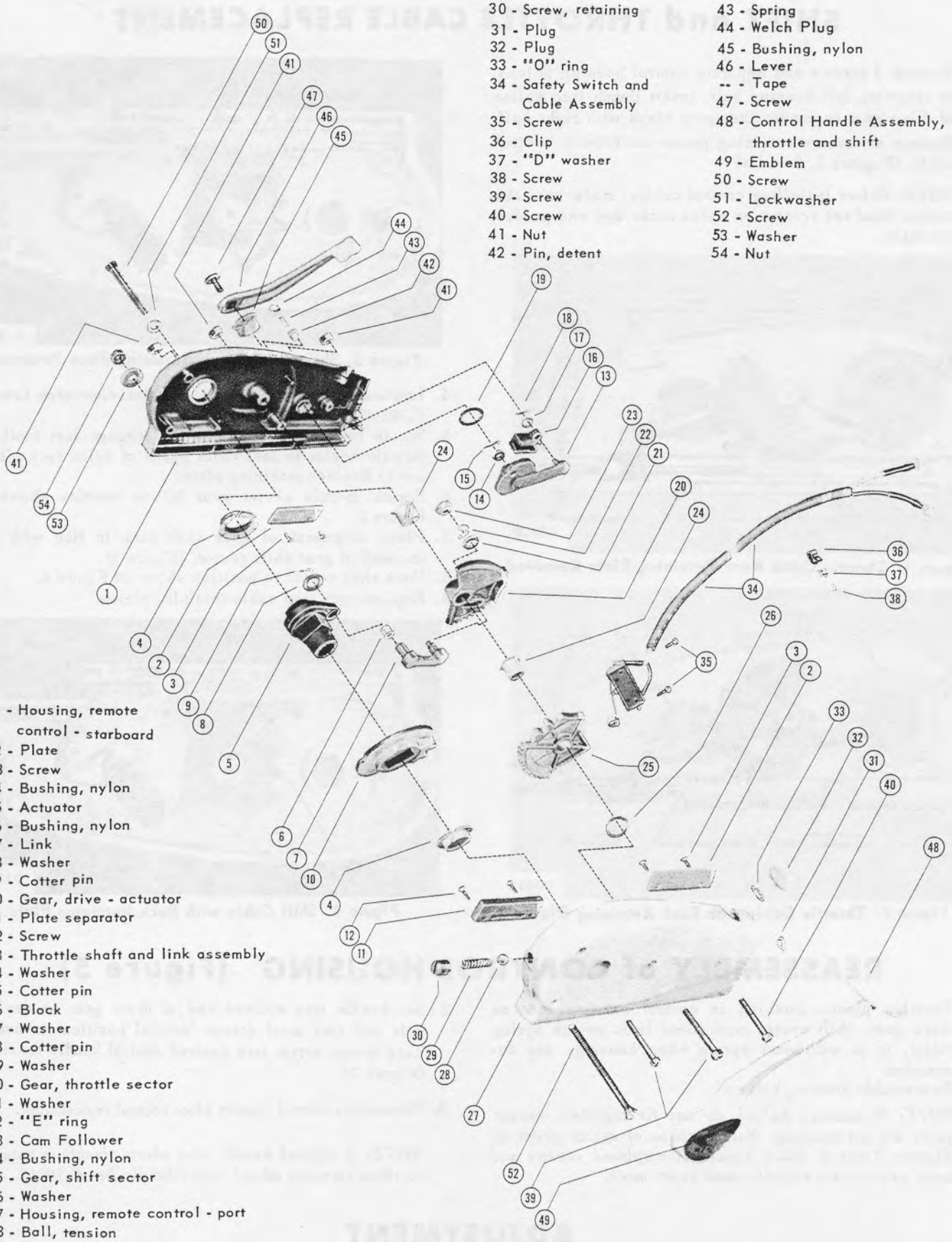


Figure 5. Remote Control Assembly

MERCONTROL B-34744A1 and B-44958A2-A5

SHIFT and THROTTLE CABLE REPLACEMENT

IMPORTANT: In order to assure proper operation of remote control, adhere to the following:

- Control cables must be correct length. Cables, which are too short, will cause hard shifting and throttle action.
- Cables should follow the shortest route to stern drive unit and engine or outboard.
- Bends should be kept to a minimum and not form less than a 12" (30.48cm) radius.
- Cables C-34555A_ must be used with this control.
- These cables are available in lengths of 5 ft. to 40 ft. by 1 ft. increments; i.e., 5, 6, 7, 8, etc. Longer cables are available on special order. (In metric table, 1 ft. is equal to 30.48cm.)

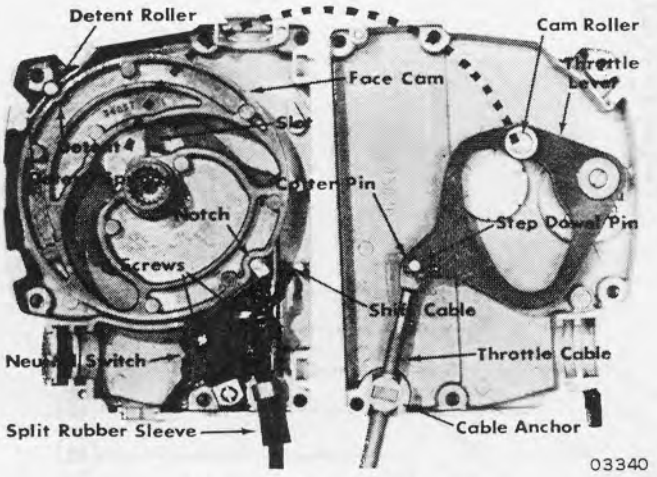


Figure 1. Control Halves

SHIFT LEVER

1. Remove 4 screws and separate control housing halves.
2. Remove detent spring and detent roller. (Figure 1)
3. Move neutral safety switch out of position. (Figure 1)
4. Lift face cam out of housing.

NOTE: Install control cable C-34555A__ of desired length. Before installing, make sure that set screws in end guides are tight.

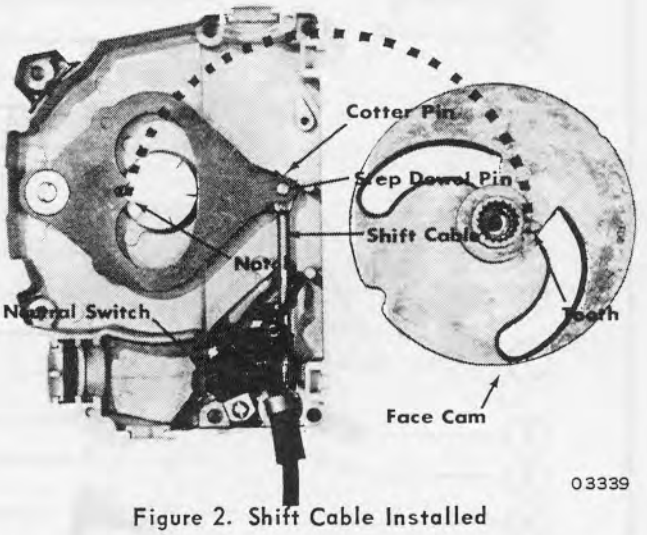


Figure 2. Shift Cable Installed

5. Remove dowel pin from shift lever to remove shift cable. (Figure 2)
6. Place Anti-Corrosion Grease (C-92-45134A1) into cable socket before installing shift cable.
7. Reassemble in the reverse order of disassembly.

NOTE: Be sure that neutral safety switch is aligned with notch of face cam. (Figure 1) Position split rubber sleeves on neutral switch cable over ends of shift and throttle cable brass barrels to keep cables in position.

THROTTLE LEVER

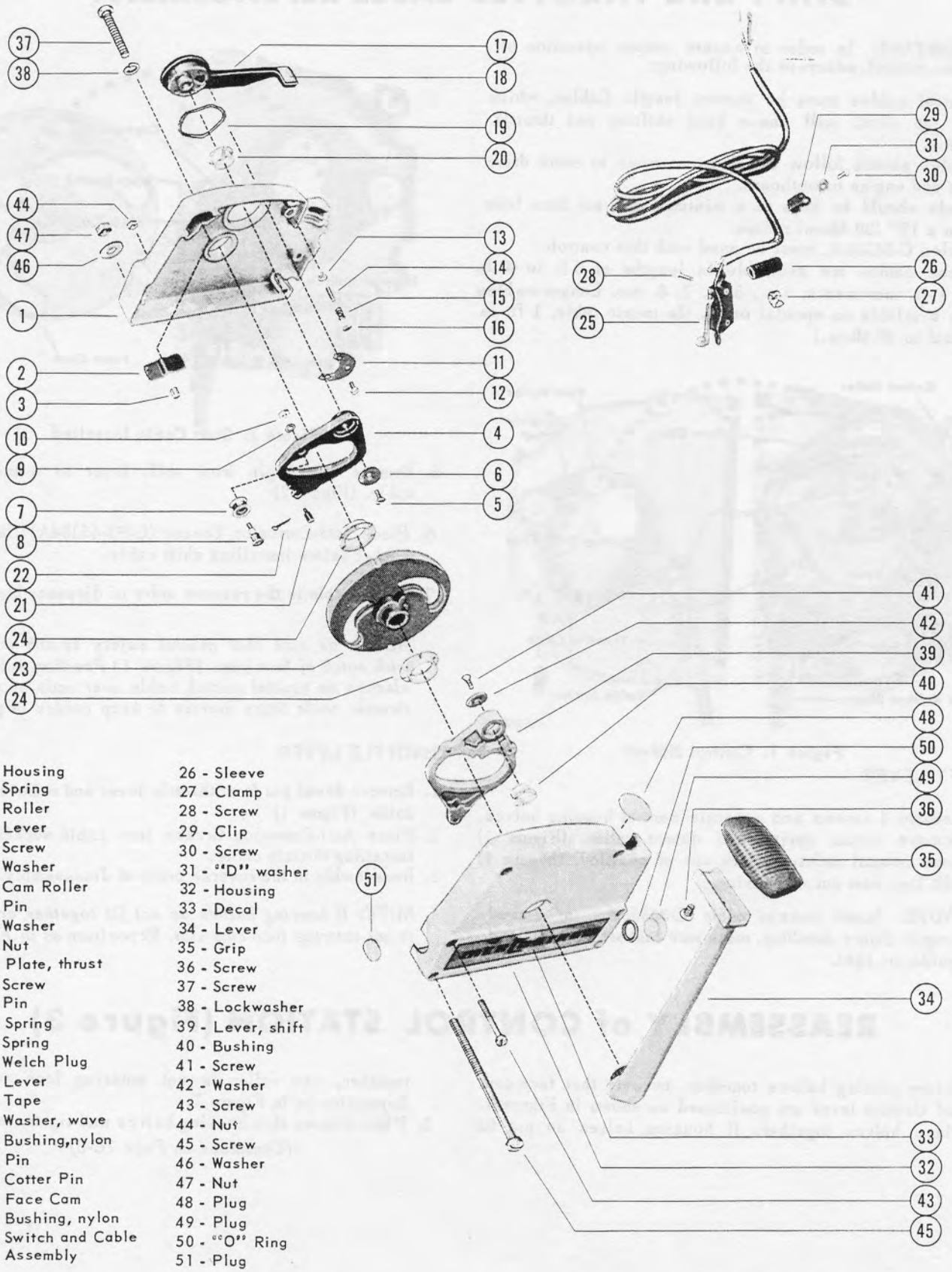
1. Remove dowel pin from throttle lever and remove throttle cable. (Figure 1)
2. Place Anti-Corrosion Grease into cable socket before installing throttle cable.
3. Reassemble in the reverse order of disassembly.

NOTE: If housing halves do not fit together, camroller is not entering face cam slot. Reposition as in Figure 1.

REASSEMBLY of CONTROL STATION (Figure 3)

1. Before placing halves together, be sure that face cam and throttle lever are positioned as shown in Figure 1.
2. Place halves together. If housing halves do not fit together, cam roller is not entering face cam slot. Reposition as in Figure 1.
3. Place screws thru housing halves and tighten evenly.

(Continued on Page 7C-5)



1 - Housing
2 - Spring
3 - Roller
4 - Lever
5 - Screw
6 - Washer
7 - Cam Roller
8 - Pin
9 - Washer
10 - Nut
11 - Plate, thrust
12 - Screw
13 - Pin
14 - Spring
15 - Spring
16 - Welch Plug
17 - Lever
18 - Tape
19 - Washer, wave
20 - Bushing,nylon
21 - Pin
22 - Cotter Pin
23 - Face Cam
24 - Bushing, nylon
25 - Switch and Cable Assembly
26 - Sleeve
27 - Clamp
28 - Screw
29 - Clip
30 - Screw
31 - "D" washer
32 - Housing
33 - Decal
34 - Lever
35 - Grip
36 - Screw
37 - Screw
38 - Lockwasher
39 - Lever, shift
40 - Bushing
41 - Screw
42 - Washer
43 - Screw
44 - Nut
45 - Screw
46 - Washer
47 - Nut
48 - Plug
49 - Plug
50 - "O" Ring
51 - Plug

Figure 3. Remote Control, Exploded View

4. Set handle into splined hub on desired side and turn until detent (neutral position) is noted. Reset handle so that handle is in vertical position. Install handle screw and lockwasher and tighten securely. (See Figure 4 for handle positions.)

5. Hand grip may be repositioned on control handle.

6. Fasten control cables to boat with clamps, "D" washers and screw. Allow cables to protrude straight back from control assembly and do not fasten to boat for at least 3 ft. from control. This will prevent placing a load or bind on cables.

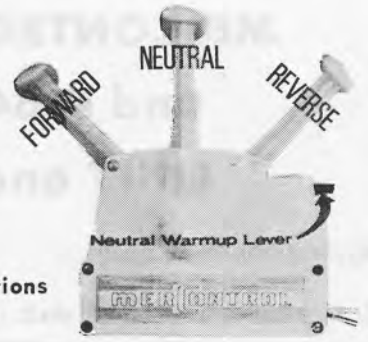


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Figure 4. Control Handle Positions

ADJUSTMENT

Refer to "Removal-Installation-Alignment", Section 2, for shift and throttle cable adjustment.

REPLACING NYLON BARREL on C-34555A_ CABLE

If nylon barrel on remote control cable C-34555A_ becomes loose or damaged, replace as follows:

1. Remove inner core wire.

   NOTE: Remove burrs (made by set screws on core wire) with a file so that inner liner of cable will not be damaged when core wire is removed. Round off end of core wire so that inner lining is not damaged when core wire is reinserted.

2. Remove damaged nylon barrel.
3. Install new brass barrel assembly (C-38685A1). Larger diameter of hole in barrel faces cable.
4. Distance from end of cable to center line of brass barrel assembly must measure exactly 1-3/8" (3.5cm). (Figure 5)

   NOTE: Brass barrel assembly must be staked or locked in place with Loctite Type "A" (C-92-32609).

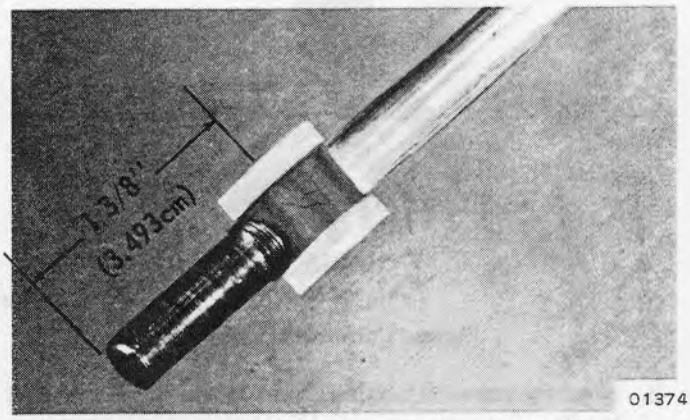

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Figure 5. Distance from Cable End to Center of Brass Barrel

REPLACEMENT INNER CORE WIRE for C-34555A_ REMOTE CONTROL CABLE

The replacement inner core wire assembly (C-36201A20 or C-36201A40) for C-34555A_ remote control cable) has the stainless steel terminal end installed and is available only in 20 ft. (6.1m) and 40 ft. (12.2m) lengths.

INSTALLATION

1. Round off end (without terminal end) of new wire to prevent damaging inner liner of cable when wire is inserted.
2. Lubricate inner core wire while sliding into outer cable.
3. Continue to insert core wire until able to grip opposite end.
4. Pull core wire until distance from centerline of hole in steel terminal end and centerline of brass barrel measures exactly 2-7/16" (6.19cm). (Figure 6)
5. Measure exactly 4" (10.16cm) from end of cable insert and cut off excess core wire. (Figure 6)
6. Install cable end guide to core wire. Tighten screws securely.

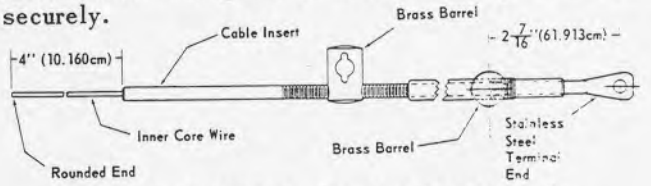

Figure 6. C-34555A_ Remote Control Cable

MERCONTROL C-37782A1-A2, B-56426A1 (215E) and B-64326A1 (225 II-TR and 255 II-TR) SHIFT and THROTTLE CABLE REPLACEMENT

REMOVING CONTROL HANDLE

1. Remove button from control shaft. (Figure 1)

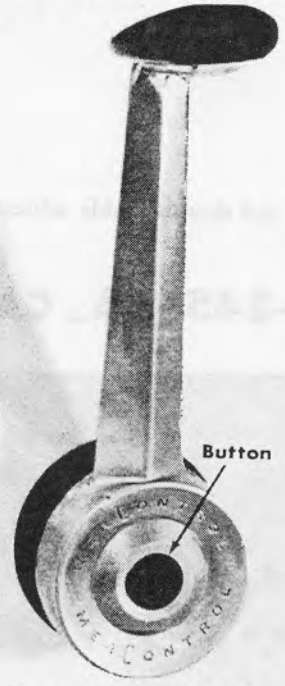

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Figure 1. Control Handle

2. Loosen set screw in handle (Figure 1) and remove control handle.
3. Remove screws which hold bezel and control to panel. (Figure 2)
4. Control and control cables may be removed.

NOTE: New control shaft assemblies are held in place by a set screw which is recessed into shoulder of throttle cam. Set screw locks into a recess in control shaft. Previous models had control shaft assembly held in place with a screw and washer located on side opposite control handle. When installing control handle on early style control, caution must be taken to hold control shaft assembly in from opposite side. If control shaft assembly is not held in place, control handle will push control shaft out and control handle will not fit on serrations properly. This may cause handle to loosen in a short time. If control handle continues to become loose on early style control, control shaft and throttle cam may be replaced by correct style which holds unit in place by set screw. Also, if control handle is not fully engaged on serrated control shaft, neutral button cannot be depressed to allow disengagement of shift control. This, in turn, would not allow acceleration of engine while in neutral gear. Repair procedure of new style is same as previous models, except that set screw must be loosened to remove control shaft assembly from throttle cam.

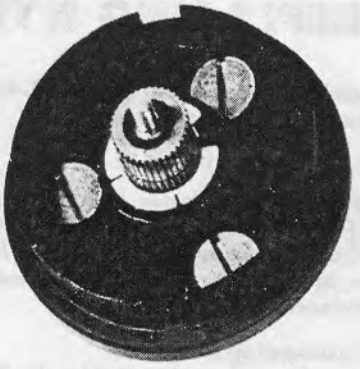

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Figure 2. Bezel Installed

IMPORTANT: In order to assure proper operation of remote control, adhere to the following:

- **Control cables must be correct length. Cables, which are too long or too short, will cause hard shifting and throttle action.**
- **Bends should be kept to a minimum and not form less than a 12" (30.48cm) radius.**
- **Cables should follow the shortest route to stern drive unit and engine.**
- **Cables C-34555A__ must be used with this control.**
- **These cables are available in lengths of 5 ft. (1.5m) to 40 ft. (12.2m) by 1 ft. (.3m) increments; i.e., 5, 6, 7, 8, etc. Longer cables are available on special order.**

CABLE REPLACEMENT

NOTE: It is not necessary to disassemble control housing to install control cables. Cable replacement procedures are the same for port or starboard controls.

1. Remove cotter pins and covers. (Figure 3)

2. Place handle on splined shaft and move handle approximately 45° toward reverse position and remove handle. This will position shift and throttle levers so that control cables can be removed or installed.

3. Control cables are held in position with pins and hair pin clips. (Figure 4)

   NOTE: Port control throttle cable is on side furthest from control handle and starboard throttle cable is on side nearest control handle.

4. Reinstall covers and cotter pins in control housing. (Figure 5)

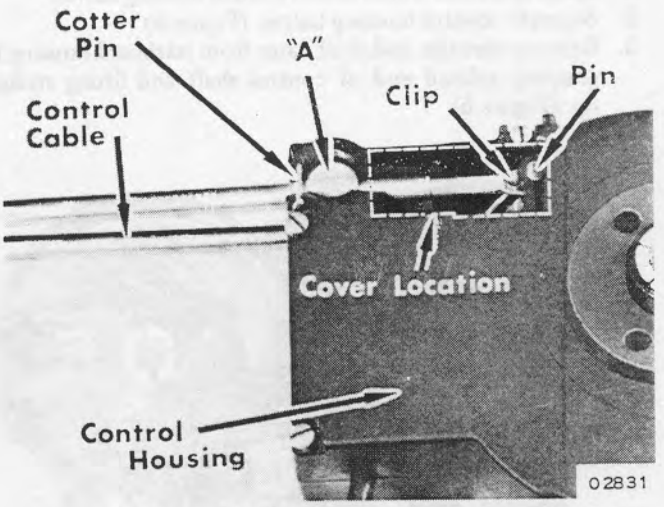

Figure 4. Control Cables Installed in Control Housing

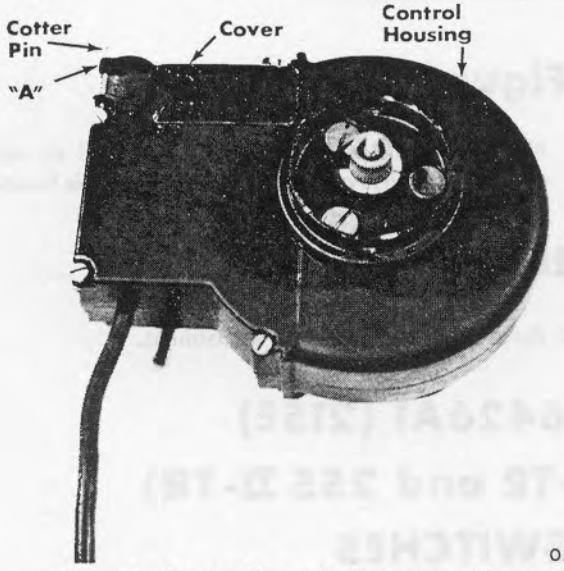

Figure 3. Cotter Pin and Cover Location

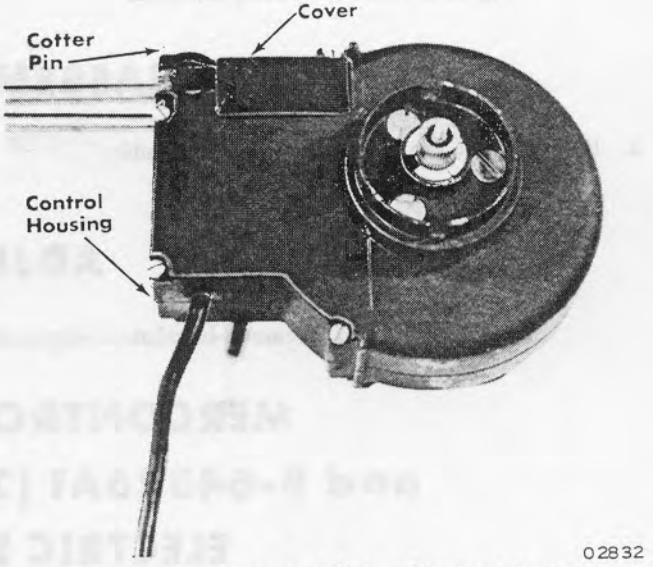

Figure 5. Cover and Cotter Pin Installation

REMOVING CONTROL SHAFTS

1. Remove screws which fasten control housing halves.
2. Separate control housing halves. (Figure 6)
3. Remove throttle and shift cams from starboard housing by grasping splined end of control shaft and lifting straight up. (Figure 6)

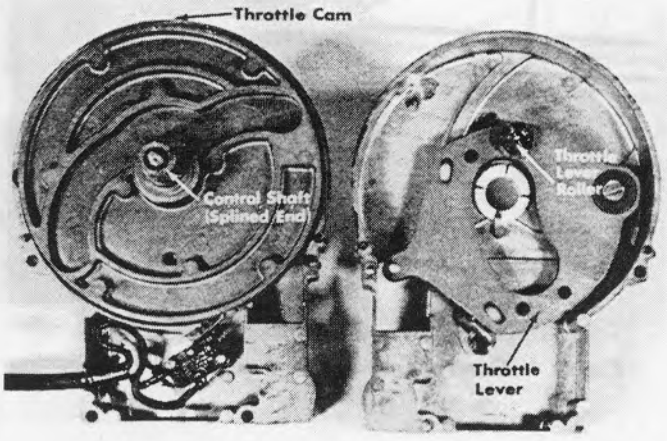

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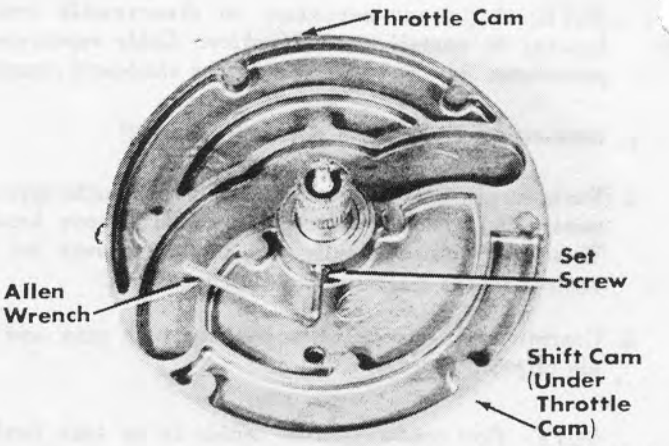
Figure 6. Control Housing Separated



02818

Figure 7. Loosening Set Screw

4. Remove set screw which secures control shaft to throttle cam. (Figure 7)
5. Remove control shaft from cams.
6. Reinstall control shaft.

REASSEMBLY (Figure 8)

1. Reassemble in the reverse order of disassembly.

NOTE: Console control shaft is installed in shift cam either way for left or right side control handle location.

ADJUSTMENT

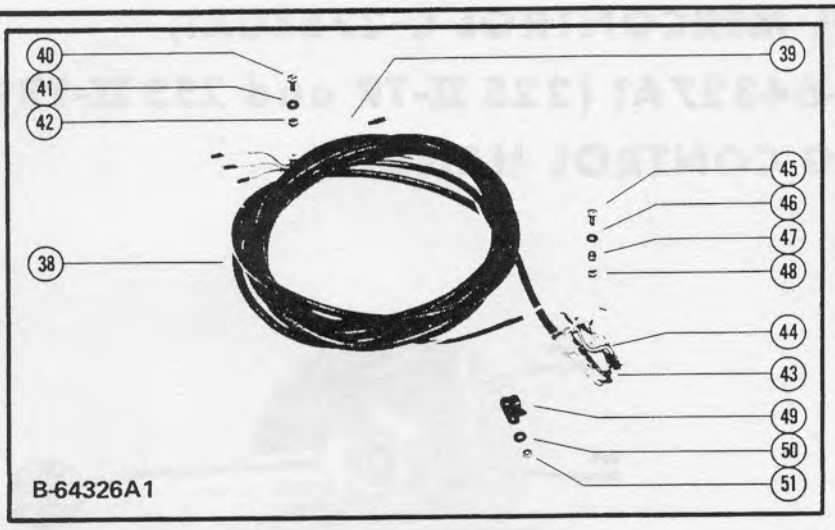
Refer to "Removal-Installation-Alignment", Section 2, for shift and throttle cable adjustment.

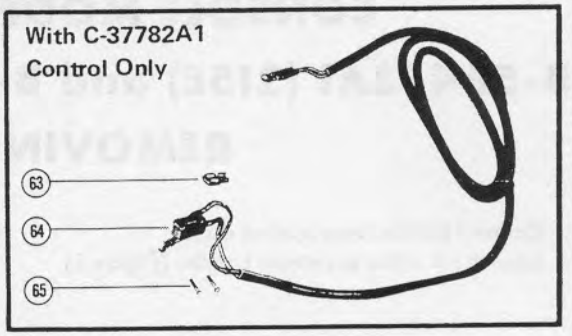
MERCONTROL B-56426A1 (215E) and B-64326A1 (225 II-TR and 255 II-TR) ELECTRIC SHIFT SWITCHES

1. For testing shift switch on electric model (Figure 8), refer to "MerCruiser B-55722 (215) and B-63063A1 (225II-TR and 255II-TR) Electric Remote Control Test Procedure", following.

NOTE: Electric model control box DOES NOT have neutral safety switch or shift cable.

2. For connecting shift wires to engine, refer to "Removal-Installation-Alignment", Section 2.





1 - Housing
2 - Cover
3 - Screw
4 - Cotter Pin
5 - Bushing
6 - Lever
7 - Plug
8 - Pin
9 - Cam Roller
10 - Nut
11 - Pin
12 - Pin (hair)
13 - Bushing
14 - Screw
15 - Washer
16 - Shaft Ass'y
17 - Cam
18 - Screw
19 - Spacer
20 - Screw
21 - Nut
22 - Cam
23 - Insert
24 - Screw
25 - Nut
26 - Pin Ass'y
27 - Spring
28 - Fastener
29 - Cover
30 - Bushing
31 - Bezel
32 - Screw
33 - Handle
34 - Screw
35 - Button
36 - Grip
37 - Screw
38 - Harness
38 - Harness Ass'y
39 - Cable Ass'y
41 - Washer
42 - Nut
43 - Switch & Plate
44 - Cable
45 - Screw
46 - Lockwasher
47 - Spacer
48 - Nut
49 - Clip
50 - Wahser
51 - Nut
52 - Switch & Harness
53 - Nut
54 - "D" Washer
55 - Clip
56 - Switch Ass'y
57 - Plate
58 - Nut
59 - Screw
60 - Nut
61 - Washer
62 - Screw
63 - Tab Receptacle
64 - Switch & Harness
65 - Screw

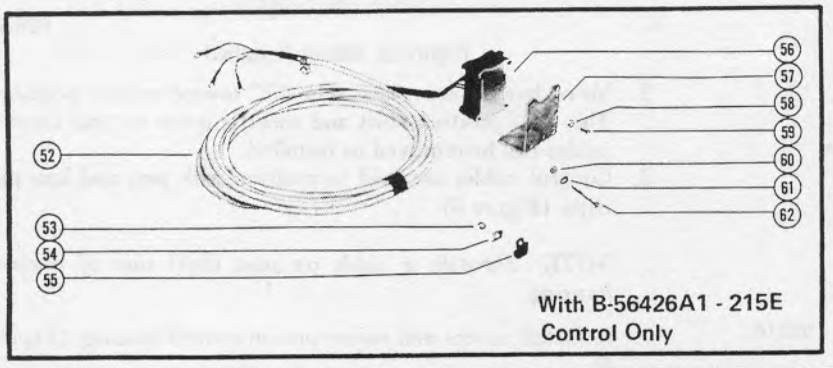


Figure 8. Remote Control, Exploded View

CONSOLE MODEL MERCONTROL C-37580A1, B-56453A1 (215E) and B-64327A1 (225 II-TR and 255 II-TR)

REMOVING CONTROL HANDLE

1. Remove button from control shaft.
2. Loosen set screw to remove handle. (Figure 1)

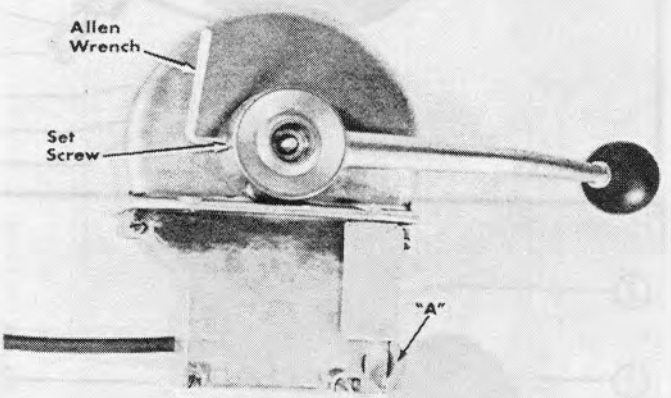


Figure 1. Tightening Set Screw

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CABLE REPLACEMENT

NOTE: It is not necessary to disassemble control housing to install control cables.

1. Remove cotter pins and covers. (Figure 2)

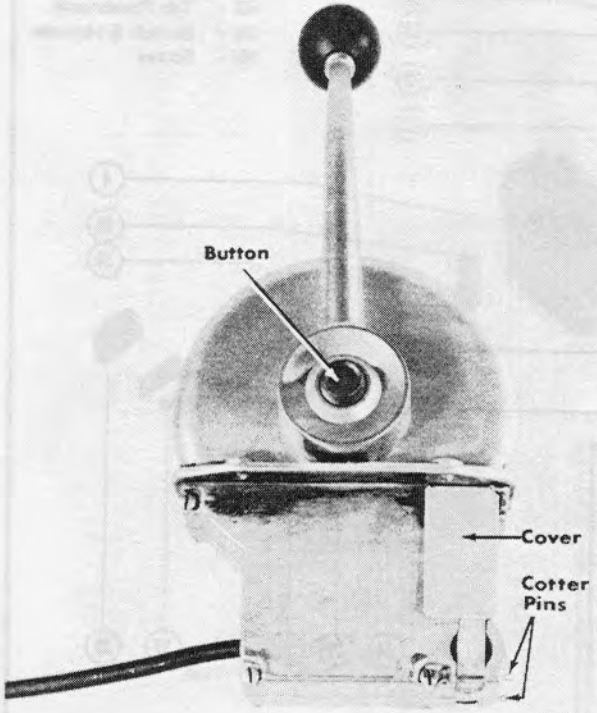

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Figure 2. Control Button Installed

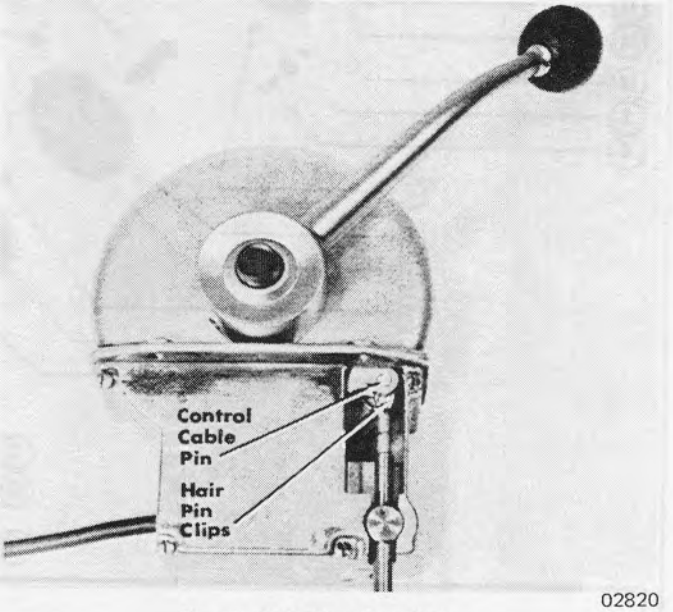

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Figure 3. Cables Installed

2. Move handle approximately 45° toward reverse position. This will position shift and throttle levers so that control cables can be removed or installed.
3. Control cables are held in position with pins and hair pin clips. (Figure 3)

   NOTE: Throttle is cable on port (left) side of control housing.

4. Reinstall covers and cotter pins in control housing. (Figure 4)

LUBRICATION

Lubricate panel controls and console controls in area where blocking pin roller rides on housing before assembling control housings. Also lubricate this area with Quicksilver Anti-Corrosion Grease (C-92-45134) when servicing these controls.

ADJUSTMENT

Refer to "Removal-Installation-Alignment", Section 2, for shift and throttle cable adjustment.

MERCONTROL B-56453A1 (215E) and B-64327A1 (225 II-TR and 255 II-TR) ELECTRIC SHIFT SWITCHES

1. For testing shift switch on electric model (Figure 4), refer to "MerCruiser B-55722 (215) and B-63063A1 (225II-TR and 255II-TR) Electric Remote Control Test Procedure", following.

   NOTE: Electric model control box DOES NOT have neutral safety switch or shift cable.

2. For connecting shift wires to engine, refer to "Removal-Installation-Alignment", Section 2.

MerControl C-37580A1, B-56453A1 and B-64327A1 Use Numbers with Suffix "A".
MerControl C-37580A2, B-56453A2 and B-64327A2 Use Numbers with Suffix "A" and "B".

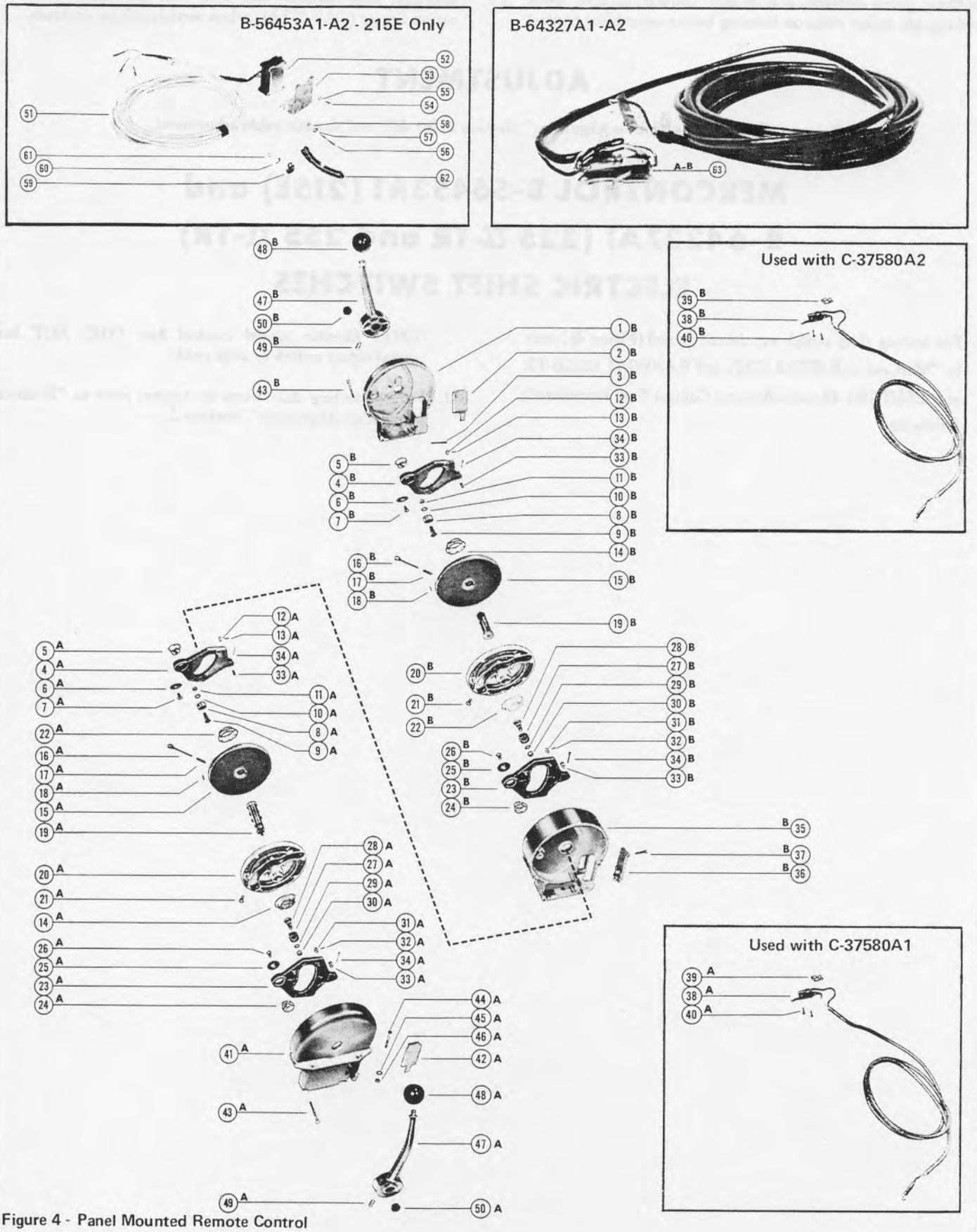


Figure 4 - Panel Mounted Remote Control

1 - Housing, remote control (starboard)
2 - Cover, control housing (starboard)
3 - Cotter Pin
4 - Lever, shift
5 - Bushing, nylon - shift lever
6 - Washer, retaining
7 - Screw
8 - Cam Roller, shift lever
9 - Pin, cam roller to shift lever
10 - Washer, cam roller pin
11 - Nut, cam roller pin
12 - Roller Guide, shift lever
13 - Pin, roller guide to shift lever
14 - Bushing, nylon
15 - Cam, shift
16 - Pin Assembly, blocking - shift cam
17 - Spring, compression - blocking pin
18 - Fastener - blocking pin to shift cam
19 - Shaft Assembly, control
20 - Cam, throttle
21 - Screw, set - throttle cam
22 - Bushing, nylon
23 - Lever, throttle
24 - Bushing, nylon
25 - Washer, retaining
26 - Screw
27 - Cam Roller, throttle lever
28 - Pin, cam roller to throttle lever
29 - Washer, cam roller pin
30 - Nut, cam roller pin
31 - Roller Guide, throttle lever
32 - Pin, roller guide to throttle lever
33 - Pin
34 - Pin (hair), control cable pin
35 - Housing, remote control (center)
36 - Plate, retainer - center housing
37 - Screw, retainer plate to center hsg.
38 - Switch and Harness Assembly, safety
39 - Tab Receptacle, safety switch
40 - Screw, safety switch to control hsg.
41 - Housing, remote control (port)
42 - Cover, control housing (port)
43 - Screw, control housing clamping
44 - Screw, remote control to boat
45 - Washer, remote control screw
46 - Nut, remote control screw
47 - Handle, control
48 - Grip, control handle (black)
49 - Screw, set
50 - Button, control handle
51 - Switch Harness Assy, shift control
52 - Switch Assembly, shift control
53 - Plate, mounting
54 - Screw
55 - Nut
56 - Screw
57 - Washer
58 - Nut
59 - Clip
60 - "D" Washer
61 - Nut
62 - Insert, shift cam
63 - Switch and Harness Assembly

(Parts' Description for Figure 4)

DUAL CONSOLE MERCONTROL C-37580A2, B-56453A2 (215E) and B-64327A2 (225 II-TR and 255 II-TR) SHIFT and THROTTLE CABLE REPLACEMENT

NOTE: It is not necessary to disassemble control housing to install control cables.

1. Remove cotter pins and covers, screws and center cover.
2. Move both control handles to vertical (neutral) position. (Figure 1)

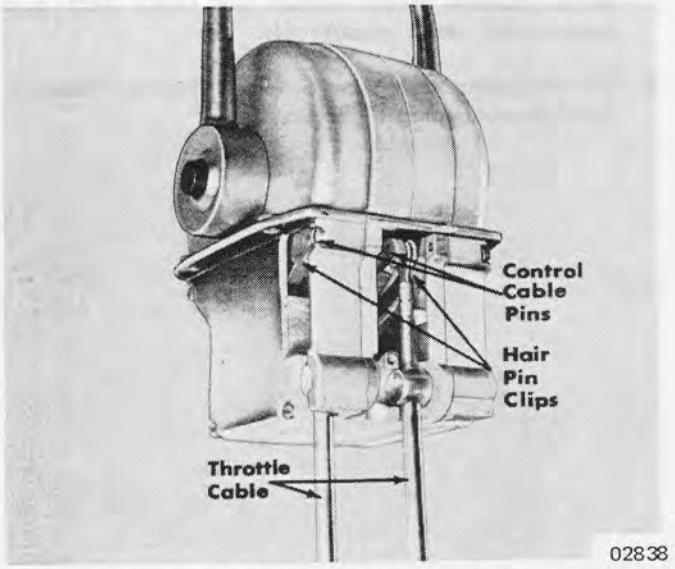


Figure 1. Throttle Cables Installed

3. Throttle cables are held in position with cable pin and hair pin clip. (Figure 2)
4. Move both control handles to reverse position.
5. Shift and throttle cables are held in position with pins and hair pin clips.
6. Reinstall cotter pins, covers and screws. (Figure 3)

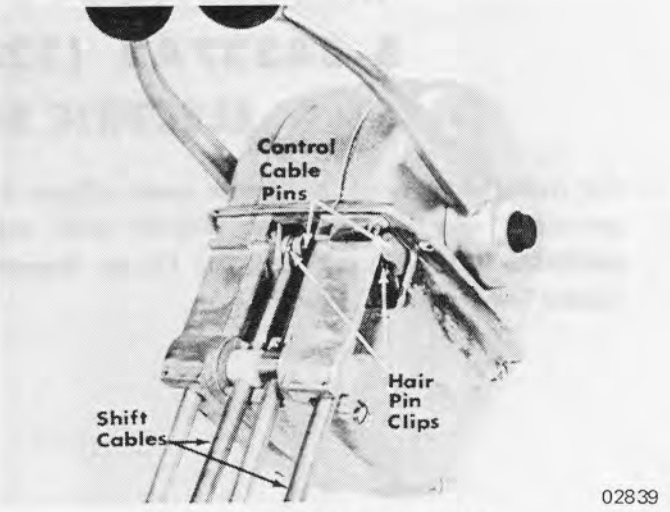


Figure 2. Shift Cables Installed

NOTE: New control shaft assemblies are held in place by a set screw which is recessed into shoulder of throttle cam. Set screw locks into a recess in control shaft. Previous models had control shaft assembly held in place with a screw and washer located on side opposite control handle. When installing control handle on early style control, caution must be taken to hold control shaft assembly in from opposite side. If control shaft assembly is not held in place, control handle will push control shaft out and control handle will not fit on serrations properly. This may cause handle to loosen in a short time. If control handle continues to become loose on early style control, the control shaft and throttle cam may be replaced by current style which holds unit in place by the set screw. Also, if control is not fully engaged on serrated control shaft,

neutral button cannot be depressed to allow disengagement of shift control. This, in turn, would not allow acceleration of engine while in neutral gear. Repair procedure of new style is same as previous models, except that set screw must be loosened to remove control shaft assembly from throttle cam.

7. Reassemble in reverse order of disassembly, preceding. (Figure 4)

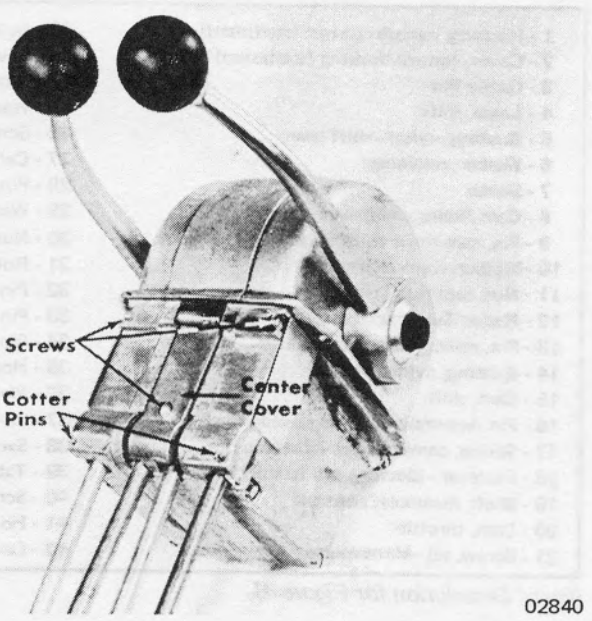


Figure 3. Covers Installed

02840

ADJUSTMENT

Refer to "Removal-Installation-Alignment", Section 2, for shift and throttle cable adjustment.

MERCONTROL B-56453A2 (215E) and B-64327A2 (225 II-TR and 255 II-TR) ELECTRIC SHIFT SWITCHES

1. For testing shift switch on electric model (Figure 4, preceding), refer to "MerCruiser B-55722 (215) and B-63063A1 (225II-TR and 255II-TR) Electric Remote Control Test Procedure", following.

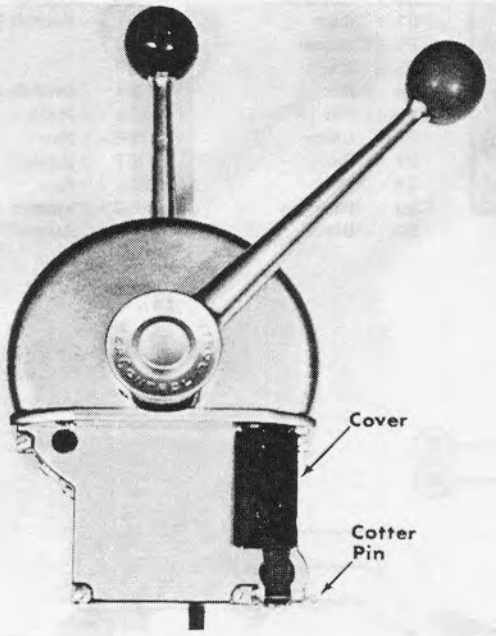
NOTE: Electric model control box DOES NOT have neutral safety switch or shift cable.

2. For connecting shift wires to engine, refer to "Removal-Installation-Alignment", Section 2.

TWO-LEVER CONSOLE MODEL MERCONTROL C-38290A1, C-58602A2, B-57147A1 (215E) and B-63064A1 (225 II-TR and 255 II-TR) SHIFT and THROTTLE CONTROL CABLE REPLACEMENT

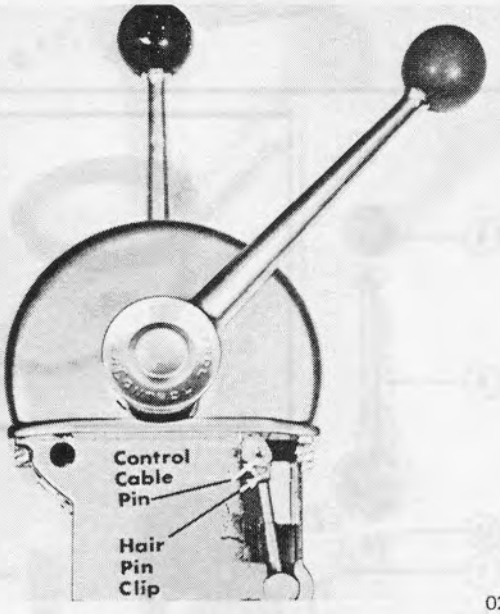
NOTE: It is not necessary to disassemble control housing to install control cables.

1. Remove cotter pins and covers. (Figure 1)
2. Move throttle handle to idle position and shift handle to reverse position. This will position shift and throttle levers so that control cables can be removed or installed.



02848

Figure 1. Removing Covers



02849

Figure 2. Cables Installed

3. Control cables are held in position with pins and hair pin clips. (Figure 2)

   NOTE: Throttle is cable on port (left) side of control housing.

4. Reinstall covers and cotter pins. (Figure 3)

ADJUSTMENT

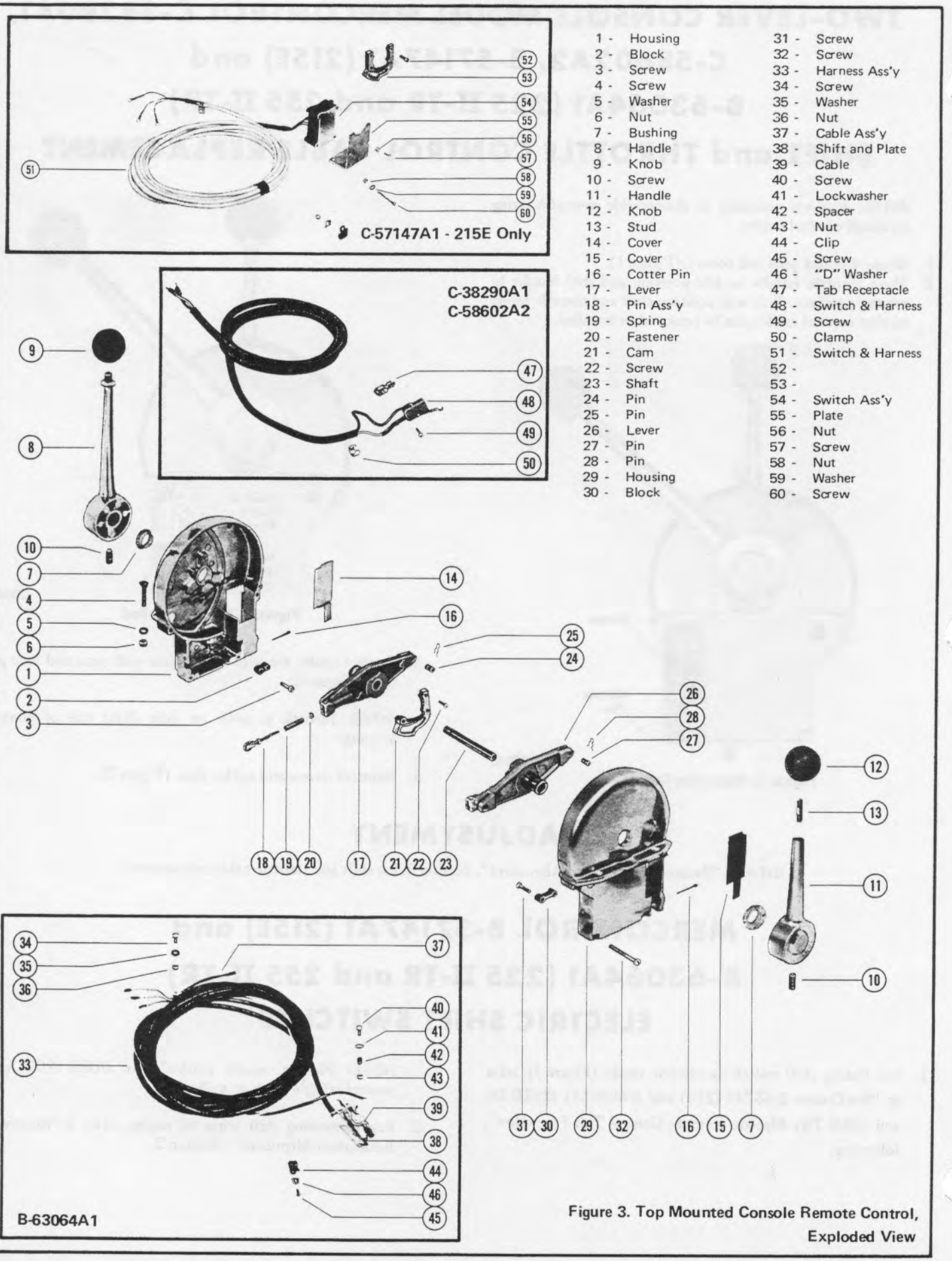
Refer to "Removal-Installation-Alignment", Section 2, for shift and throttle cable adjustment.

MERCONTROL B-57147A1 (215E) and B-63064A1 (225 II-TR and 255 II-TR) ELECTRIC SHIFT SWITCHES

1. For testing shift switch on electric model (Figure 3), refer to "MerCruiser B-55722 (215) and B-63063A1 (225II-TR and 255II-TR) Electric Remote Control Test Procedure", following.

   NOTE: Electric model control box DOES NOT have neutral safety switch or shift cable.

2. For connecting shift wires to engine, refer to"Removal-Installation-Alignment", Section 2.



1 - Housing
2 - Block
3 - Screw
4 - Screw
5 - Washer
6 - Nut
7 - Bushing
8 - Handle
9 - Knob
10 - Screw
11 - Handle
12 - Knob
13 - Stud
14 - Cover
15 - Cover
16 - Cotter Pin
17 - Lever
18 - Pin Ass'y
19 - Spring
20 - Fastener
21 - Cam
22 - Screw
23 - Shaft
24 - Pin
25 - Pin
26 - Lever
27 - Pin
28 - Pin
29 - Housing
30 - Block
31 - Screw
32 - Screw
33 - Harness Ass'y
34 - Screw
35 - Washer
36 - Nut
37 - Cable Ass'y
38 - Shift and Plate
39 - Cable
40 - Screw
41 - Lockwasher
42 - Spacer
43 - Nut
44 - Clip
45 - Screw
46 - "D" Washer
47 - Tab Receptacle
48 - Switch & Harness
49 - Screw
50 - Clamp
51 - Switch & Harness
52 -
53 -
54 - Switch Ass'y
55 - Plate
56 - Nut
57 - Screw
58 - Nut
59 - Washer
60 - Screw

Figure 3. Top Mounted Console Remote Control, Exploded View

DUAL STATION CONTROL KIT C-38290A2
TWO-LEVER CONSOLE MOUNTED MERCONTROL
DUAL STATION (Single Motor)
SHIFT and THROTTLE CONTROL CABLE REPLACEMENT

CONTROL STATION NO. 1

1. Use two C-38286A_ control cables of desired length.
2. Remove cotter pins and covers from control housing. (Figure 1)
3. Move throttle handle to idle position and shift handle to reverse position. This will position shift and throttle levers so that control cables can be installed.

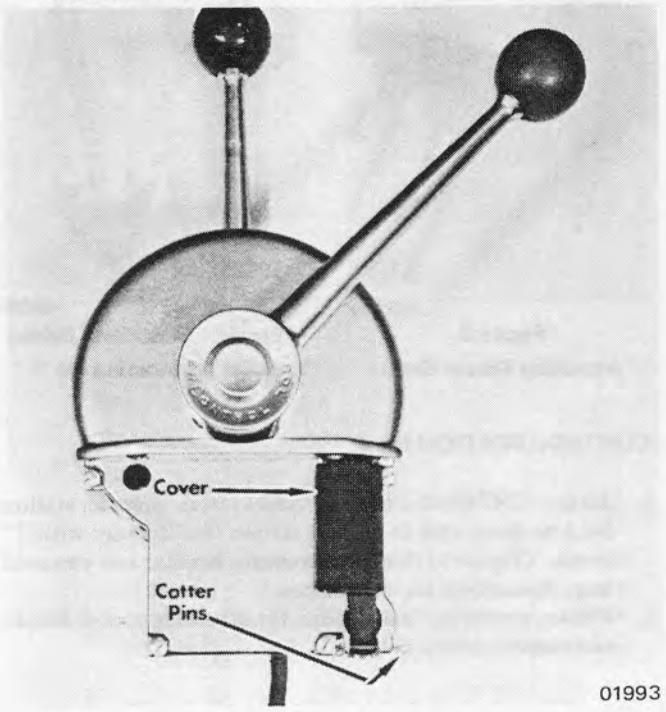


Figure 1. Cotter Pins and Cover Location

4. Position control cables in control housing and install contron cable pins and hair pin clips. (Figure 2)

   NOTE: Throttle cable is on port (left) side of control housing.

5. Reinstall covers and cotter pins in control housing.

CONTROL STATION NO. 2

1. Use two C-38286A_ control cables of desired length.
2. Move throttle handle to fast position and shift handle to forward position. This will position throttle and shift levers so that control cables can be removed or installed.
3. Control cables are held in position with pins and hair pin clips. (Figure 3)

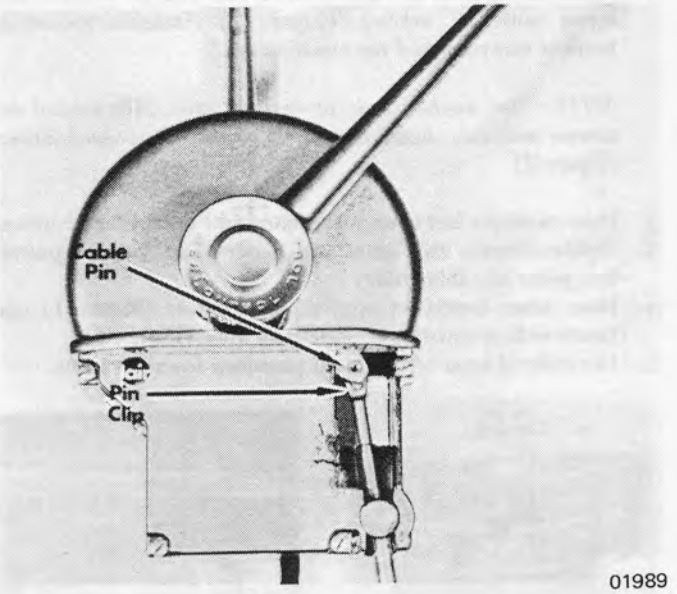


Figure 2. Pins and Clips Location

NOTE: Throttle cable is on port (left) side of control.

IMPORTANT: A Power Shift Cylinder (B-38638A2) is required with a dual station control kit.

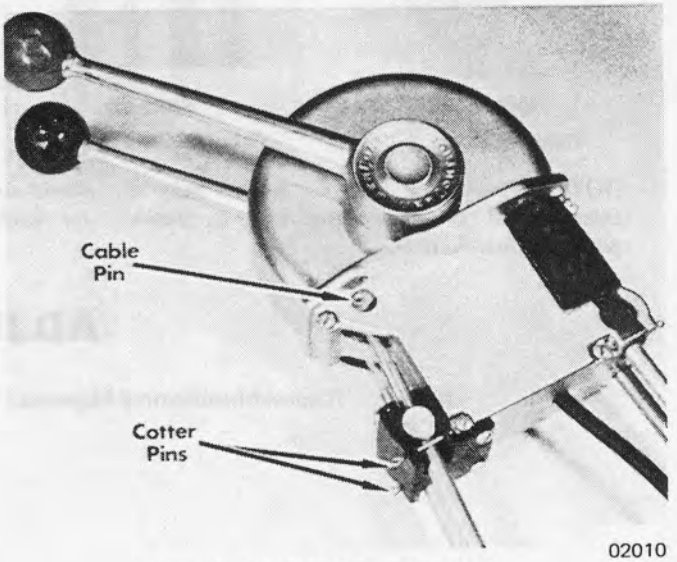


Figure 3. Control Cables Installed

ADJUSTMENT

Refer to "Removal-Installation-Alignment", Section 2, for shift and throttle cable adjustment.

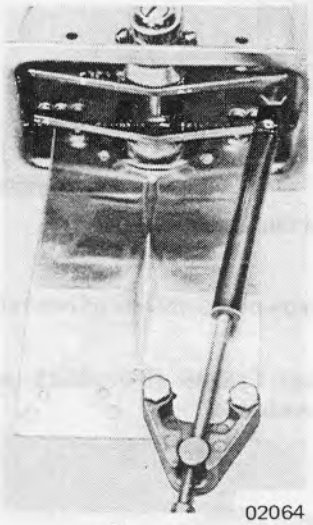
TWO-LEVER TOP MOUNTED CONTROL
C-32669A1 - DUAL STATION
SHIFT and THROTTLE CONTROL CABLE REPLACEMENT

CONTROL STATION NO. 1

1. Cable end guides are attached to rear end of control box levers with 1" screws. (Figure 1) (Outside mounting bracket was removed for clarification.)

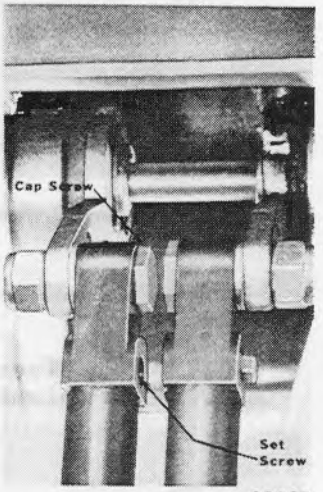
   NOTE: Use anchor hole at end of lever. Allen head set screws and hex head cap screws must face each other. (Figure 2)

2. Place washers between cable ends and control box levers.
3. Tighten elastic stop nuts and back off slightly to permit free pivot of cable guide.
4. Place brass barrel in spacer block halves (Figure 1) and fasten with screws and elastic stop nuts. (Figure 3)
5. Use control lever with detent positions for shift cable.



02064

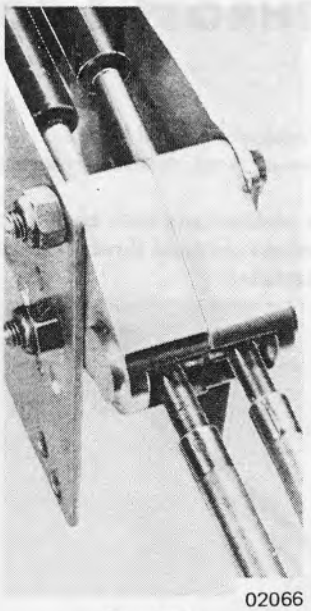
Figure 1.
Cable Position



02065

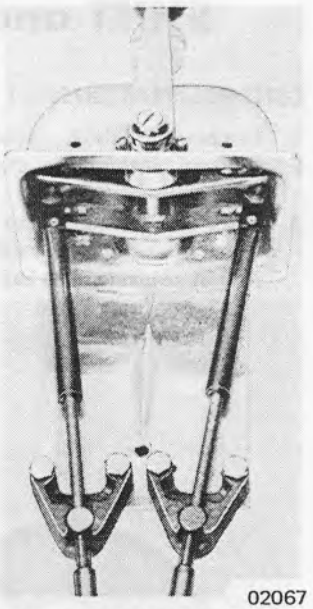
Figure 2.
Cable Guides Attached

NOTE: Handles, knobs and detents may be moved or interchanged in the control box, as desired, for each particular installation.



02066

Figure 3.
Attaching Spacer Blocks



02067

Figure 4. Attaching Cables to Control Station No. 2

CONTROL STATION NO. 2

1. Attach C-37404A__ control cables from control station No.1 to front end of control station No. 2 levers with 1" screws. (Figure 4) (Outside mounting bracket was removed from illustration for clarification.)
2. Follow preceding instructions for attaching spacer blocks and control cables. (Figure 5)

NOTE: Two C-29564-S control cables are required from station No. 2 to engine and Power Shift.

IMPORTANT: Power Shift unit (B-38638A2) is required with shift cable (C-34555A__).

ADJUSTMENT

Refer to "Removal-Installation-Alignment", Section 2, for shift and throttle cable adjustment.

MERCRUISER B-55722A2 (215E) and B-63063A1 (225 II-TR and 255 II-TR) ELECTRIC REMOTE CONTROL

THROTTLE CABLE REPLACEMENT

REMOVAL

1. Remove 3 screws and retaining plate.
2. Remove cotter pin and washer, then throttle cable. (Fig. 1)

REPLACEMENT

1. Place throttle cable end on anchor pin and barrel in recess.
2. Install washer and cotter pin.
3. Install retaining plate with 3 screws.

ADJUSTMENT

Refer to "MerCruiser Removal, Installation and Alignment" Section 2 for shift and throttle cable adjustment.

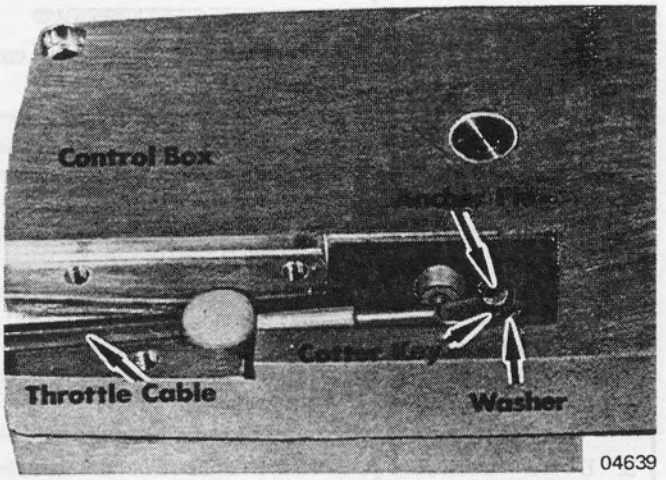


Figure 1. Typical Washer and Cotter Pin Location

TROUBLESHOOTING B-55722A2 CONTROL

MALFUNCTION	CAUSES	REMEDY
1. Actuator box will not shift.	a. Low battery charge. b. Burned fuse. c. Shift harness not properly grounded. d. Loose wire. e. Box has open circuit(s). f. Shift harness not properly connected to actuator box.	a. Charge battery or b. Replace fuse (20 amp). c. Attach ground lug at end of shift harness to actuator box with screw. d. Check fuse wire for breaks or loose connections. e. Replace actuator box. f. Check wires and attach properly to actuator box.
2. Drive will not shift to forward. 3. Drive will not shift to reverse. 4. Drive will not shift to neutral.	a. Cam follower stuck in control station. b. Switch or harness has an open circuit. c. Box has open circuit. d. Gear in drive shaft housing turned on shaft. e. Piece of metal jammed between crank and housing. f. Short in harness (frayed wire). g. Shift harness not properly connected to actuator box.	a. Free cam follower or replace parts. b. Replace part(s). c. Replace actuator box. d. Check fuse wire for breaks or loose connections. e. Remove metal; replace parts if defective. f. Replace harness. g. Refer to Installation Manual or Service Manual.
5. Drive oscilates from forward to reverse with control in neutral.	a. Switch in control handle defective. b. Shorted harness.	a. Replace part(s). b. Replace harness.
6. Drive remains in reverse when control is in neutral and oscilates when control is in forward.	a. Cam follower is stuck. b. Switch harness has short.	a. Free cam follower or replace parts. b. Replace parts.
7. Ratcheting noise in actuator box.	a. Relay in actuator box deteriorated.	a. Replace actuator box.
8. Flexible shaft twisted or broken.	a. Broken gear tooth jammed between crank and housing. b. Gear in drive shaft housing turned on shaft. c. Allen screw backed out of gear. d. Gear and pinion require excessive torque to turn them.	a. Replace parts. b. Replace parts. c. Turn screw into gear and replace parts. d. Inspect parts, grease gears or replace parts.
9. Box runs continually in one direction.	a. Jammed switch in actuator box. b. Bad relay.	a. Replace box. b. Replace box.

NOTE: For electrical malfunctions, shift actuator and remote control must be checked separately.

CAUTION: DO NOT short wires together or ground any wires or terminal studs (unless indicated in "Test Procedure", following) or shift actuator will become damaged.

DISASSEMBLY

1. With control lever in neutral position, remove lever cover (Figure 2) and 3 allen head screws. Lift connector and remove 3 screws and lever retainer plate. Scribe alignment mark on lever and shaft and pull off control lever.

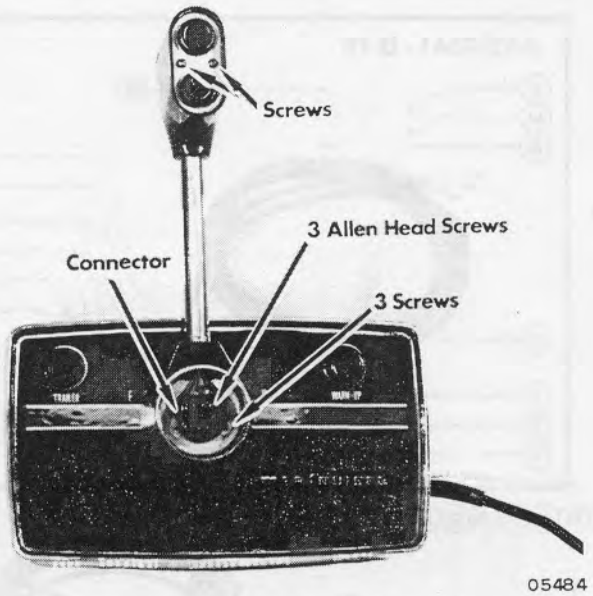


Figure 2. Control Lever Cover Removed

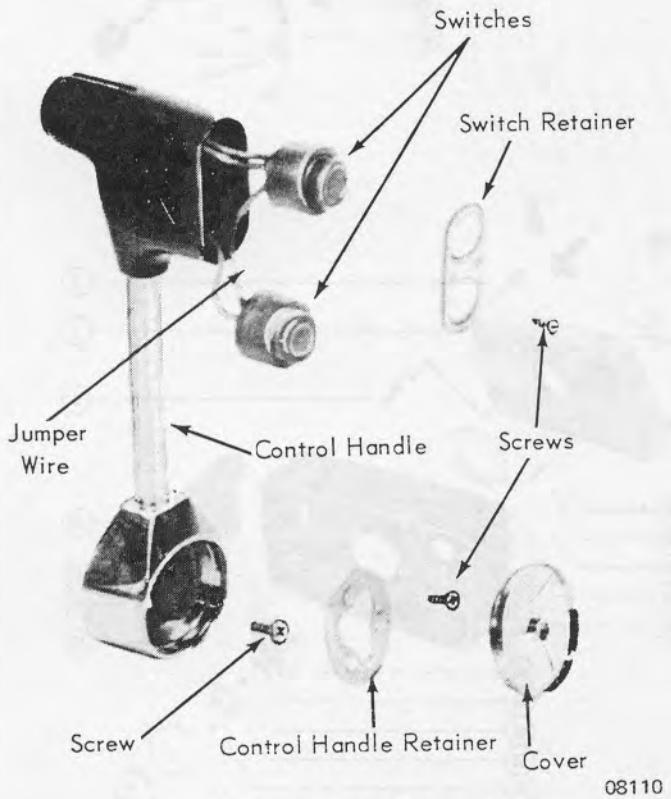


Figure 3. Control Lever Disassembled

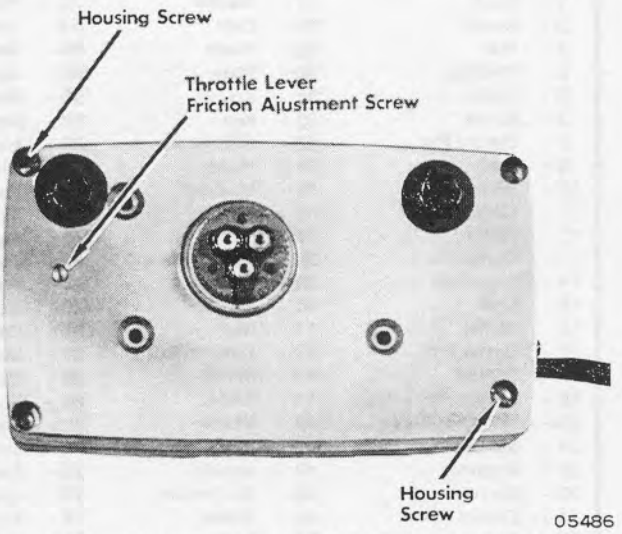


Figure 4. Housing Screws and Throttle Friction Adjustment

2. Remove 2 screws in lever, remove plate and pull out rubber boot and switch. (Figure 3) Switches may be unsoldered for replacement.
3. With care, use screwdriver to pry sides and top of case away from housing. Remove case.
4. Remove 2 housing screws (Figure 4) and separate housing halves.
5. Remove 2 cotter pins and remove throttle levers, nyliner and spacer. (Figure 5)
6. Remove wires from terminal block, noting position. Remove 2 harness clips and remove trim harness.
7. Remove 4 locknuts and washers from shift switch. Remove shift switch and throttle cam assembly simultaneously.
8. Remove screws and disassemble throttle cam. (Figure 6)
9. Remove 2 screws and retainer plate and remove "trailer" switch. Switch may be unsoldered for replacement.

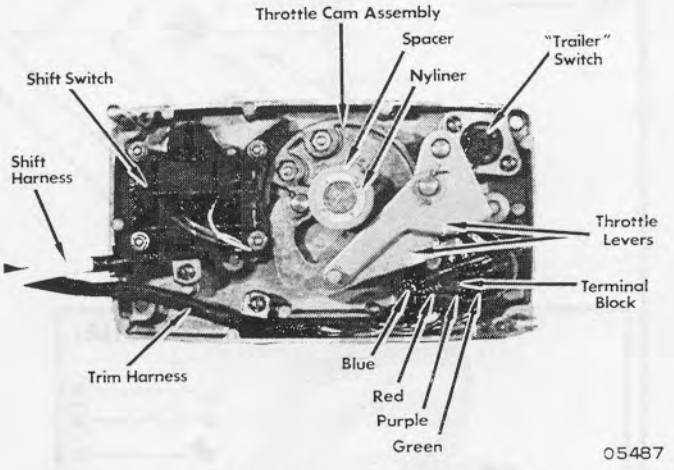
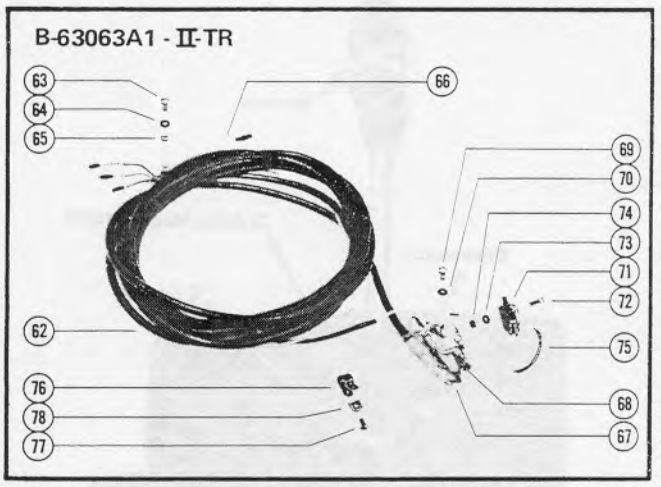
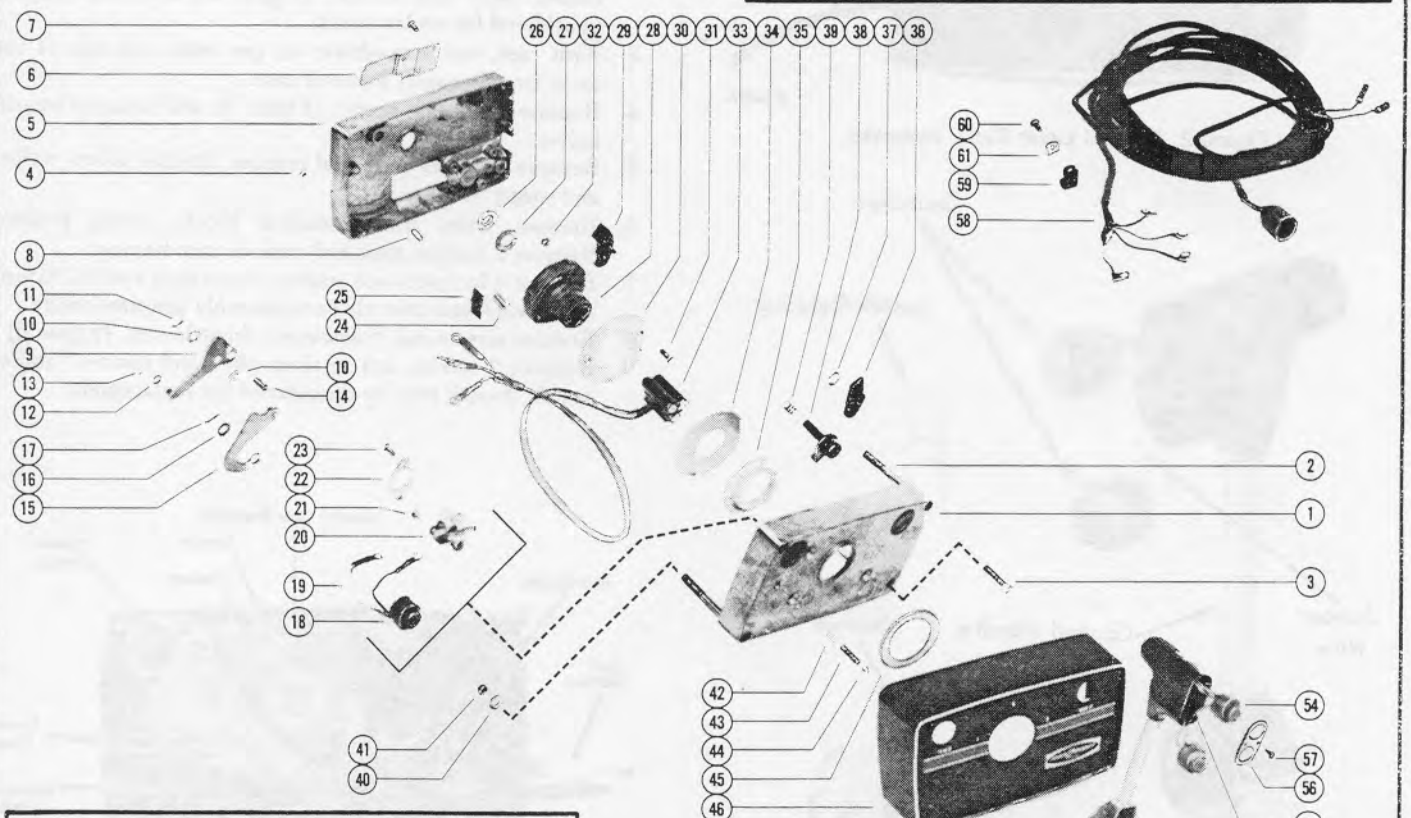


Figure 5. Port Case, Throttle Levers in Position

1 - Housing Ass'y
2 - Stud
3 - Screw
4 - Nut
5 - Housing
6 - Cover
7 - Screw
8 - Detent Pin
9 - Lever
10 - Washer
11 - Cotter Pin
12 - Washer
13 - Cotter Pin
14 - Pin, pivot
15 - Link
16 - Washer
17 - Cotter Pin
18 - Switch
19 - Jumper Wire Ass'y
20 - Terminal Block
21 - Screw
22 - Retainer
23 - Screw
24 - Detent Pin
25 - Spring
26 - Bushing
27 - Washer
28 - Cam
29 - Insert
30 - Plate
31 - Screw
32 - Nut
33 - Disconnect
34 - Plate
35 - Bushing
36 - Lever
37 - Spring
38 - Button Ass'y
39 - Spring
40 - Washer
41 - Nut
42 - Detent Pin
43 - Spring
44 - Screw
45 - Washer
46 - Cover
47 - Handle
48 - Connector
49 - Screw
50 - Plate
51 - Screw
52 - Retainer
53 - Cover
54 - Switch Ass'y
55 - Jumper Wire
56 - Retainer
57 - Screw
58 - Harness
59 - Clip
60 - Screw
61 - "D" Washer
62 - Harness
63 - Screw Ass'y
64 - Washer
65 - Nut
66 - Cable Ass'y
67 - Switch and Plate
68 - Cable
69 - Screw
70 - Washer
71 - Switch
72 - Screw
73 - Lockwasher
74 - Nut
75 - Cable
76 - Clip
77 - Screw
78 - "D" Washer
79 - Switch and Cable
80 - Nut
81 - Washer
82 - Switch
83 - Stud
84 - Screw
85 - "D" Washer
86 - Clip





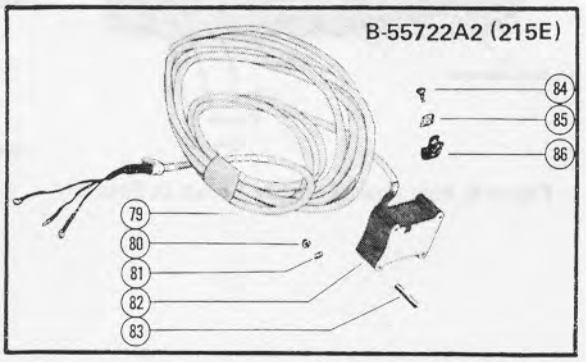


Figure 6. Deluxe MerControl

THROTTLE LEVER FRICTION ADJUSTMENT

Turn friction screw (Figure 4) to attain desired control handle tension.

REASSEMBLY

Reassembly is the reverse procedure of "Disassembly", preceding.

REMOTE CONTROL ELECTRICAL TEST PROCEDURE (215E)

1. Disconnect shift harness from actuator.
2. Connect continuity meter (or continuity light) between green wire and ground lug. (Figure 7)
   a. Shift control to neutral.
      (1) Meter should indicate open circuit.
      (2) If meter indicates closed circuit, switch or harness has a short.
   b. Shift control to forward.
      (1) Meter should indicate closed circuit.
      (2) If meter indicates open circuit, cam follower is stuck, or switch harness has open circuit.
   c. Shift control to reverse. Test same as "2a", immediately preceding.
3. Connect continuity meter (or continuity light) between blue wire and ground lug.
   a. Shift control to neutral.
      (1) Meter should indicate open circuit.
      (2) If meter indicates closed circuit, cam follower is stuck or switch harness has short.
   b. Shift control to forward. Test same as "3a", immediately preceding.
   c. Shift control to reverse.
      (1) Meter should indicate closed circuit.
      (2) If meter indicates open circuit, switch or harness has open circuit.
4. Connect shift harness to actuator box and actuator box to battery. Connect voltmeter between orange terminal and ground.
      (1) With control handle and drive in neutral, voltmeter should read zero.
      (2) If voltmeter reads above zero, switch is defective.

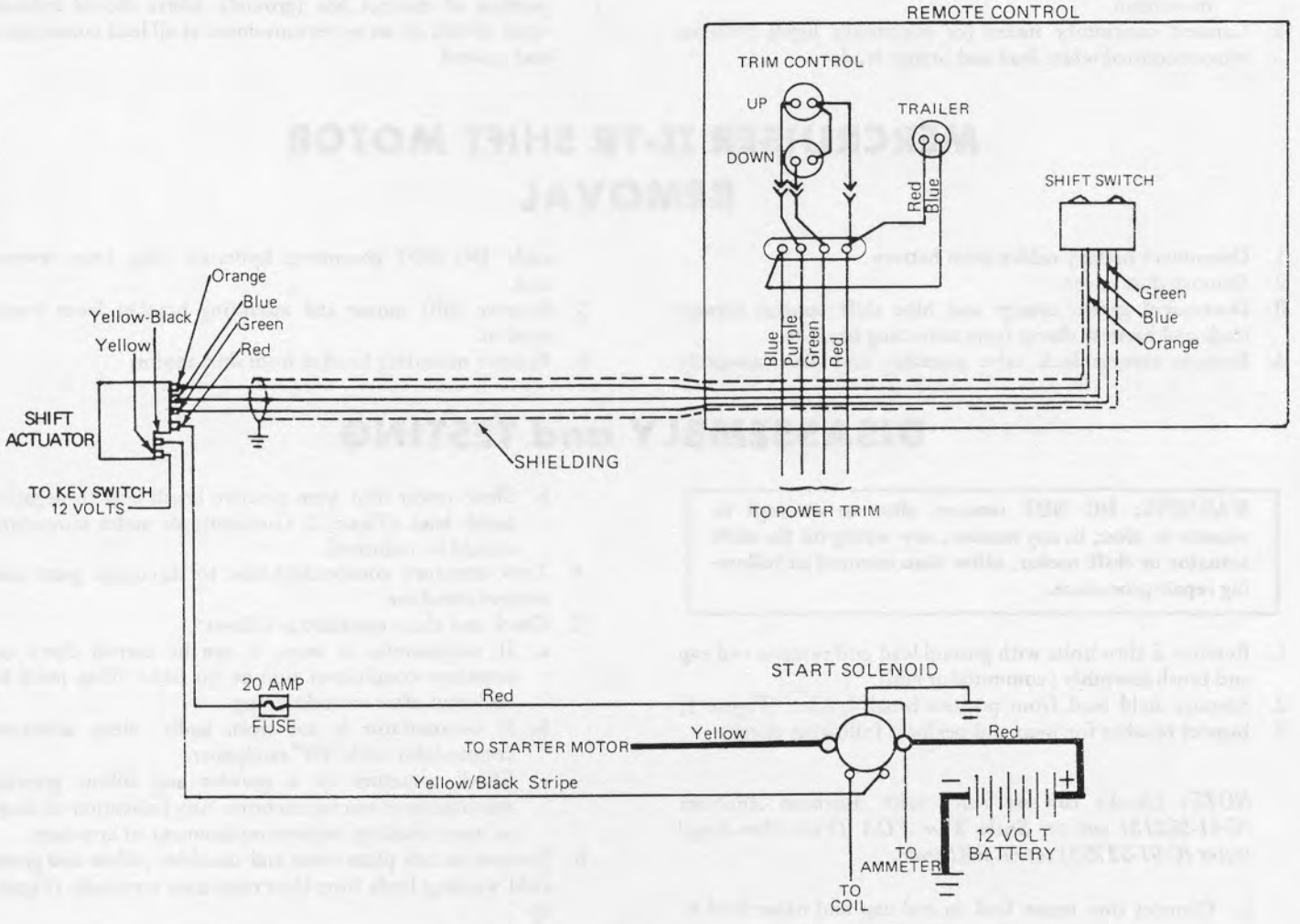


Figure 7. Remote Control Wiring Diagram

REMOTE CONTROL ELECTRICAL TEST PROCEDURE (225 II-TR and 255 II-TR)

CAUTION: Disconnect battery leads from battery before attempting any of the following steps.

1. Disconnect control shift harness white lead at instrumentation and control shift harness leads from shift motor.
2. Connect continuity meter (or continuity light) between remote control white lead and metal portion of control box (ground).
   a. Neutral - Meter should indicate open circuit or no meter movement.
   b. Forward - Meter should indicate open circuit or no meter movement.
   c. Reverse - Meter should indicate open circuit or no meter movement. If meter indicates closed circuit or meter movement, switch(es) or harness has a short.
3. Connect continuity meter (or continuity light) between remote control white lead and blue lead.
   a. Neutral - Meter should indicate open circuit or no meter movement.
   b. Forward - Meter should indicate open circuit or no meter movement.
   c. Reverse - Meter should indicate closed circuit or meter movement.
4. Connect continuity meter (or continuity light) between remote control white lead and orange lead.
   a. Neutral - Meter should indicate closed circuit or meter movement.
   b. Forward - Meter should indicate open circuit or no meter movement.
   c. Reverse - Meter should indicate open circuit or no meter movement.
5. Connect continuity meter (or continuity light) between remote control white and green lead.
   a. Neutral - Meter should indicate open circuit or no meter movement.
   b. Forward - Meter should indicate closed circuit or meter movement.
   c. Reverse - Meter should indicate open circuit or no meter movement.

(MERCONTROL B-63064A1 ONLY)

6. Push in warm-up button and shift to full forward. Button must stay engaged. Connect continuity meter (or continuity light) to remote control white lead and other meter leads alternately to blue, orange, green wires and metal portion of control box (ground). Meter should indicate open circuit or no meter movement at all lead connections and ground.

MERCRUISER II-TR SHIFT MOTOR REMOVAL

1. Disconnect battery cables from battery.
2. Remove dust cover.
3. Disconnect green, orange and blue shift control harness leads and harness clamp from mounting bracket.
4. Remove reverse lock valve assembly and place assembly aside. DO NOT disconnect hydraulic lines from reverse lock.
5. Remove shift motor and mounting bracket from transmission.
6. Remove mounting bracket from shift motor.

DISASSEMBLY and TESTING

WARNING: DO NOT remove, alter or attempt to remove or alter, in any manner, any wiring on the shift actuator or shift motor, other than covered in following repair procedure.

1. Remove 2 thru bolts with ground lead and remove end cap and brush assembly (commutator end).
2. Remove field lead from positive brush holder. (Figure 1)
3. Inspect brushes for wear and perform following checks:

NOTE: Checks can be made with Magneto Analyzer (C-91-25213) set on Scale 3 or VOA (Volt-Ohm-Amp) tester (C-91-52751) set on RXI scale.

   a. Connect one tester lead to end cap and other lead to positive brush lead. (Figure 1) No continuity nor meter movement should be indicated.
   b. Move tester lead from positive brush lead to negative brush lead. (Figure 2) Continuity or meter movement should be indicated.
4. Turn armature counterclockwise to disengage gears and remove armature.
5. Check and clean armature as follows:
   a. If commutator is worn, it can be turned down on armature conditioner tool or on lathe. Mica must be undercut after reconditioning.
   b. If commutator is not worn badly, clean armature commutator with "00" sandpaper.
   c. Check armature on a growler and follow growler manufacturer test instructions. Any indication of short or open windings requires replacement of armature.
6. Remove switch plate cover and unsolder yellow and green field winding leads from their respective terminals. (Figure 3)
7. Feed field winding leads thru end plate rubber grommet and remove field and frame assembly.

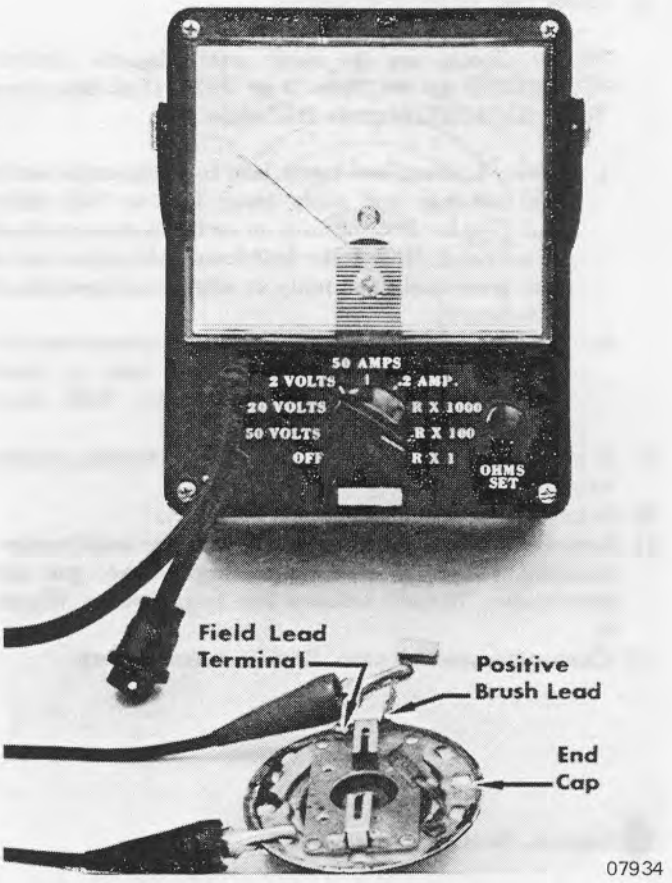


Figure 1. Testing End Cap and Brush Assembly

Figure 2. Testing End Cap and Brush Assembly

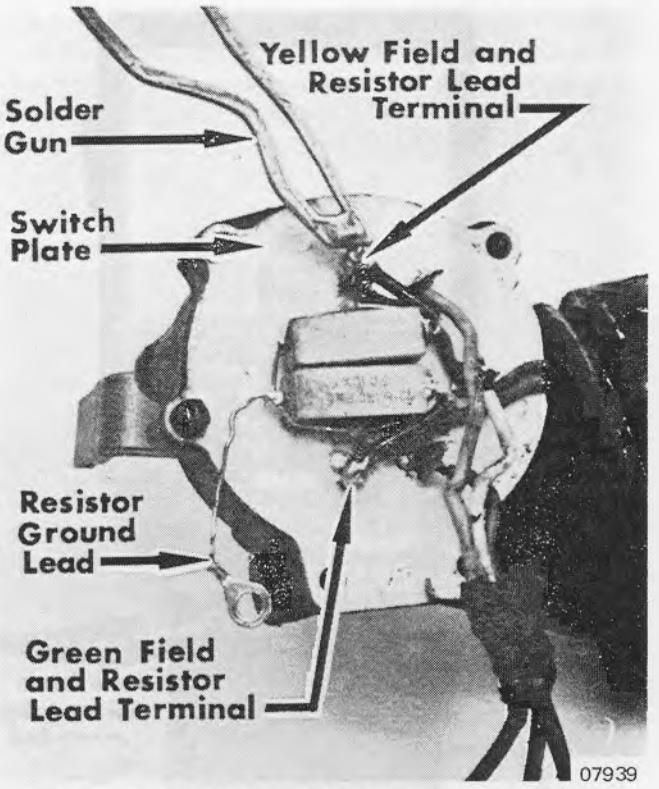


Figure 3. Switch Plate and Field Winding Leads

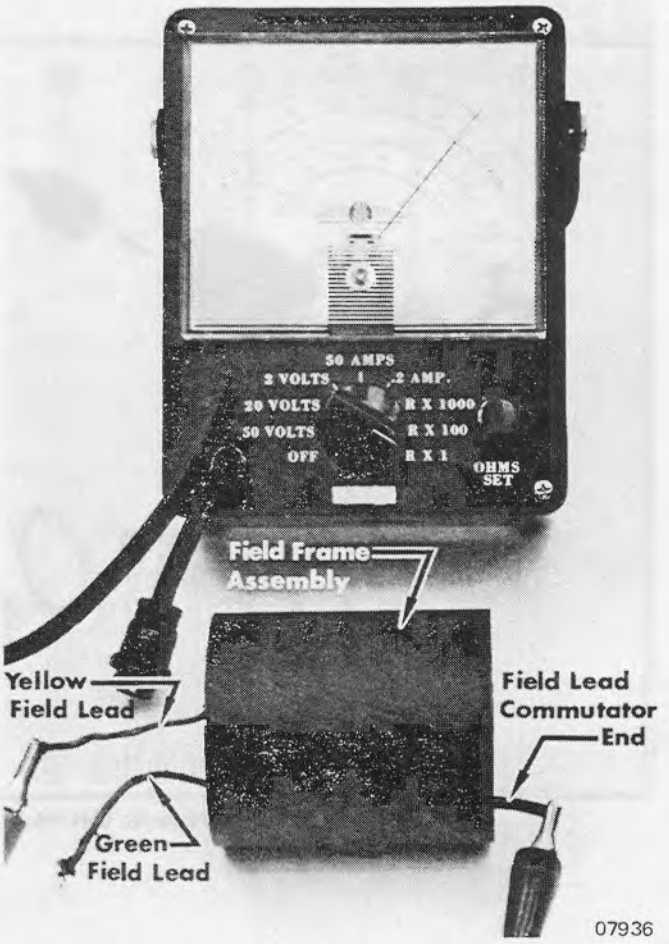


Figure 4. Testing Field for Open

8. Check field windings as follows:

   NOTE: Checks can be made with Magneto Analyzer (C-91-25213) set on Scale 3 or VOA (Volt-Ohm-Amp) Tester (C-91-52751) set on RXI scale.

   a. Open - Connect one tester lead to commutator end of field windings and other tester lead to field yellow lead. (Figure 4) Continuity or meter movement should be indicated. Move tester lead from field yellow lead to field green lead. Continuity or meter movement should be indicated.
   b. Short - Connect one lead of tester to commutator end of field winding and other tester lead to frame assembly. (Figure 5) NO continuity NOR meter movement should be indicated.
9. If meter indicates a short or open in field winding, replace fields.
10. Remove switch plate and harness assembly.
11. Remove nut from actuator arm and remove metal washer, insulating washer, 2 brass plates, large washer, gear and drive washer. Remove actuator arm from housing. (Figure 6)
12. Clean and inspect all parts. Replace defective parts.

Figure 5. Testing Field for Short

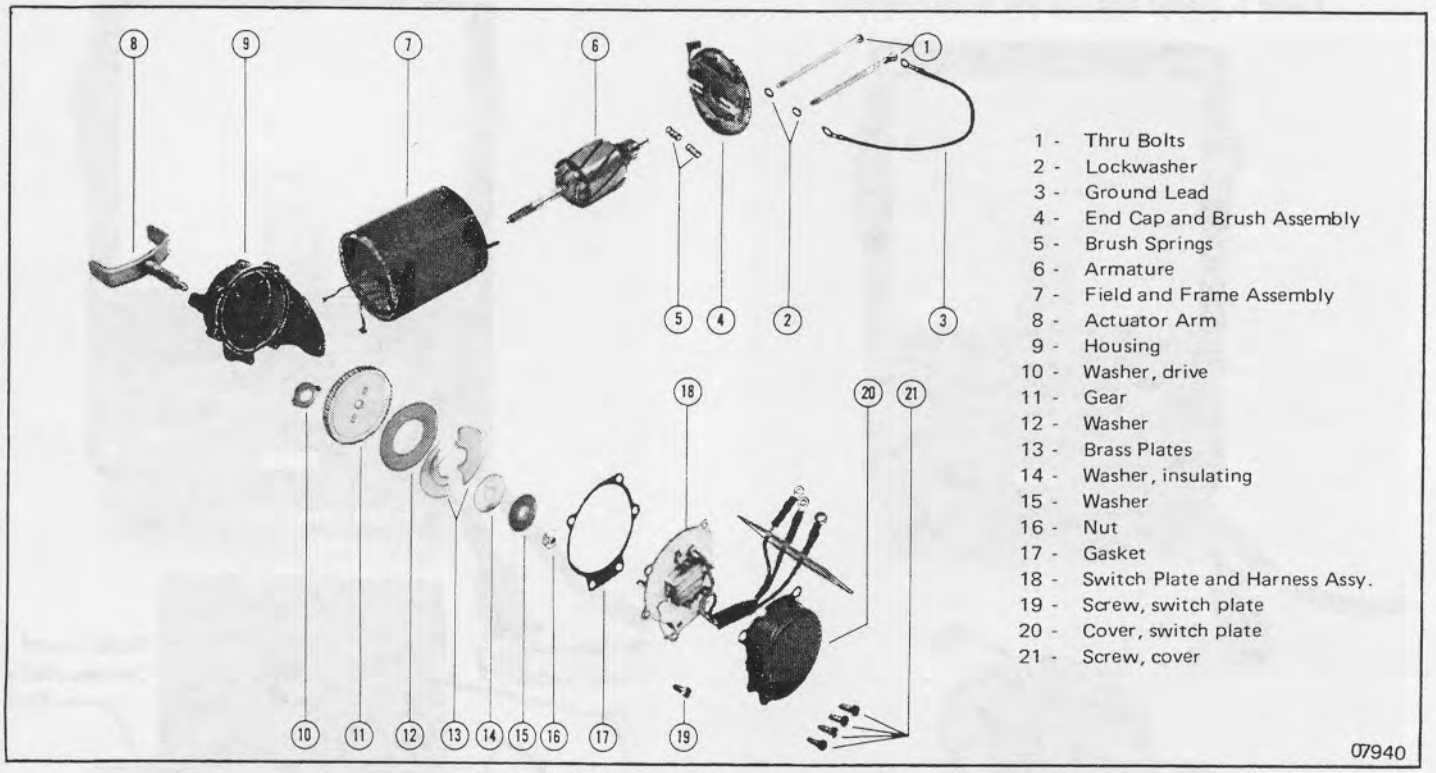


Figure 6. Shift Motor and Actuator, Exploded View

TESTING NEUTRAL SAFETY SWITCH

1. Remove switch leads from starter solenoid and from terminal block (located on flywheel housing).
2. Test can be made with Magneto Analyzer (C-91-25213) set on Scale 3 or VOA (Volt-Ohm-Amp) Tester (C-91-52752) set on RXI scale. Connect one tester lead to each switch lead and check following.
   a. Shift remote control into neutral. Meter should indicate continuity or meter movement.
   b. Shift remote control into forward. Meter should indicate no continuity nor meter movement.
   c. Shift remote control into reverse. Meter should indicate no continuity nor meter movement. If switch is defective, replace switch.

REASSEMBLY

WARNING: DO NOT remove, alter or attempt to remove or alter, in any manner, any wiring on shift actuator or shift motor, other than covered in following repair procedure.

1. Apply Liquid Neoprene (C-92-25711-1) to mating surface on end of frame assembly, install onto end plate and insert field yellow and green leads thru rubber grommet.
2. Use 50-50 tin-lead alloy resin core solder and solder field lead (commutator end) to positive brush holder. (Figure 1, preceding)
3. Install armature thru field and frame assembly.

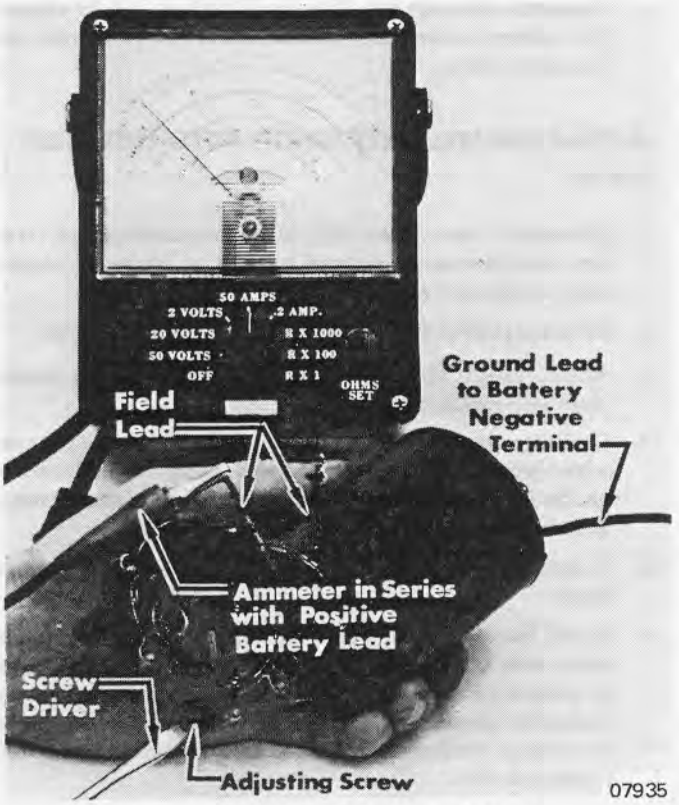


Figure 7. Adjusting Armature Preload

4. Apply Liquid Neoprene to upper edge of frame assembly, depress springs and brushes into holders and slide over commutator bars. Align locating tab on cover with notch on frame assembly. Do not chip or mar brushes.
5. Install thru bolts into cap, including ground wire under one bolt.
6. Adjust armature preload as follows:
   a. Shift actuator gear must be removed to adjust armature preload.
   b. Turn preload adjusting screw (Figure 7) counterclockwise one full turn.
   c. Connect shift motor ground wire (located under thru bolt) to negative terminal of battery. Battery should not be more than 12 volts.
   d. Connect positive battery terminal, with ammeter in series, to either field lead. (Figure 7) This will allow motor to run.

   NOTE: If field leads are soldered to switch plate terminals, positive battery lead may be attached to proper terminal.
   e. With motor running, observe ammeter and turn adjusting screw clockwise to obtain 3 amp draw, then turn screw counterclockwise ¼ to 3/8-turn.
   f. Apply Liquid Neoprene (C-92-25711-1) to head of adjusting screw so that screw does not move after adjustment.
7. Solder field leads to switch plate as shown in Figure 3, preceding. Use 50-50 tin-lead alloy resin core solder. Be sure that resistor leads also are attached to switch plate field lead terminals.
8. Coat all switch terminals with Liquid Neoprene.
9. Install actuator arm into housing. Install drive washer (tabs toward gear), gear (lettered side down), large washer, 2 brass plates (tabs into slots in gear), insulating washer (tabs into slots in gear), metal washer and nut, as shown in Figure 6. Tighten nut securely.
10. Use a new gasket under switch plate. Apply Liquid Neoprene to mating surface of switch plate cover and install cover. Install resistor ground lead under one screw.

CAUTION: Shift motor and actuator must be watertight. Make sure that all mating surfaces are sealed with Liquid Neoprene (C-91-25711-1).

INSTALLATION

1. Turn transmission shift lever counterclockwise against its stop. This is reverse position of transmission.
2. Shift the shift motor into reverse position by connecting motor black ground lead to negative battery terminal and motor harness blue lead to positive battery terminal. Remove leads from battery.

CAUTION: DO NOT remove battery leads until motor completes its shift cycle.

3. Attach mounting bracket to shift motor.
4. Insert shift motor actuator arms into slots on transmission shift lever and mount shift motor assembly to transmission.
5. Install reverse lock assembly.
6. Install shift motor harness and control box harness on junction block, matching colors.
7. Attach control harness clamp to motor mounting bracket.
8. Install dust cover.

MERCRUISER 215E SHIFT ACTUATOR (B-54240A7)

TROUBLESHOOTING

NEUTRAL START SWITCH

1. If engine will not crank, place shift control in neutral. With ignition key in "Off" position, check for continuity between 2 yellow wires (located on terminal block). (Figure 1) If continuity is not present, then neutral start switch (located in actuator) is defective, and actuator must be replaced. If continuity is present between 2 yellow wires, neutral start switch is good, and cranking circuit should be checked.
2. Neutral start switch should not have continuity in either forward or reverse gear.

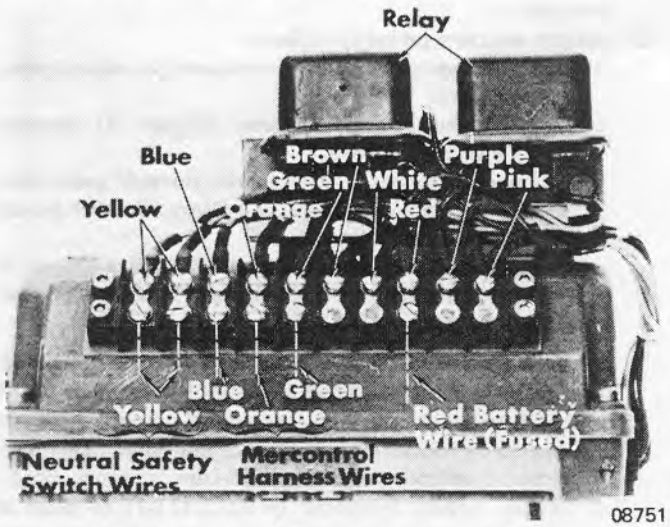


Figure 1. Shift Actuator Wire Connections

ACTUATOR DOES NOT SHIFT PROPERLY

1. Check condition of fuse (located in red wire between engine harness and actuator terminal block).
2. Check all wire connections for tightness.
3. Disconnect shift control box wiring harness (3 wires - blue, orange and green) from shift actuator terminal block.

WARNING: While testing shift actuator, stay clear of safety clutch and drive unit shift cable. Moving parts may cause injury.

4. Connect one end of jumper lead to ground and other end alternately to green, orange and blue wires coming from shift actuator. If actuator shifts into forward, neutral and reverse gear (when using jumper lead), shift control box is bad. For testing shift control box, refer to proper control repair in this section.

ACTUATOR WILL NOT SHIFT INTO FORWARD GEAR

1. Disconnect fuse from shift actuator power supply (red) wire and disconnect control box wiring harness (3 wires - blue, orange and green).
2. Disconnect green and pink wires from terminal block.
3. Rotate safety clutch to reverse gear position (clockwise) until it stops.
4. Connect continuity meter or test light between green and pink wire from actuator harness. Meter should indicate continuity, or test lamp should light. If not, shift actuator is bad and needs replacement.
5. If test in Step 4 is OK, remove purple wires from terminal block.
6. Install fuse and connect jumper lead between ground and pink wire from relay. Connect voltmeter positive (+) lead to pink and negative (-) lead to purple wires from relay. Voltmeter should read 12 volts if battery is fully charged. No voltage reading indicates bad relay. Replace relay and reconnect wires.

ACTUATOR WILL NOT SHIFT INTO REVERSE GEAR

1. Disconnect fuse from shift actuator power supply (red) wire and disconnect control box wiring harness (3 wires - blue, orange and green).
2. Disconnect blue and white wires from terminal block.
3. Rotate safety clutch to forward gear position (counter-clockwise) until it stops.
4. Connect continuity meter or test light between blue and white wires from actuator harness. Meter should indicate continuity, or test lamp should light. If not, shift actuator is bad and needs replacement.
5. If test in Step 4 is OK, remove brown wire from terminal block.
6. Install fuse and connect jumper lead between ground and white wire from relay. Connect voltmeter positive (+) lead to brown and negative (-) lead to white wires from relay. Voltmeter should read 12 volts, if battery is fully charged. No voltage reading indicates bad relay. Replace relay and reconnect wires.

NOTE: If actuator will not shift into any gear, motor (inside actuator) is bad, and actuator needs replacement.

SECTION 7 - ACCESSORIES

MERCRUISER

PART D - COOLING

MERCURY MARINE

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COOLING SYSTEM DESCRIPTION

STANDARD COOLING

MerCruiser models with over 90 horsepower have dual pump cooling. One pump is used to pull water up to the engine, the other to circulate water in the engine. Thermostatic heat control provides fast engine warmup and controlled water temperature at all times. On the MerCruiser 60-80-90, one pump is used to pick up and circulate water through the engine.

CLOSED COOLING SYSTEM

Engines, which are equipped with a closed cooling system, are cooled with fresh water circulated through a heat exchanger. Fresh water in the system is cooled by sea water which flows through the heat exchanger and is discharged overboard.

The fresh water section of the cooling system is pressurized, and the coolant temperature is thermostatically controlled. The cooling system is sealed by a pressure type filler cap.

PRECAUTIONS

Do not operate engine without cooling water flowing through sea water pump, or pump will be damaged. Do not remove heat exchanger cap while engine is hot.

INSPECTION

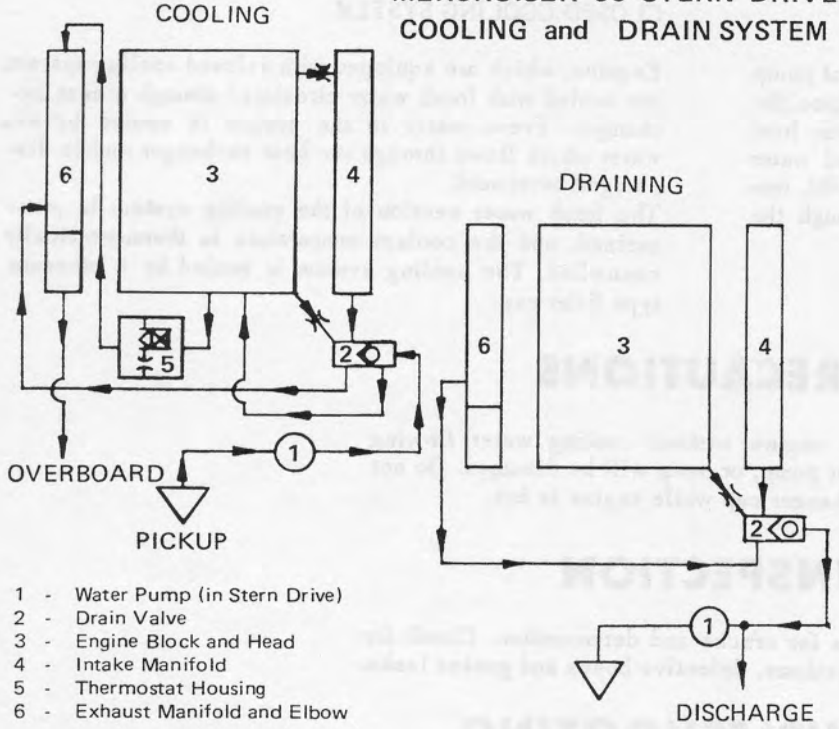
Inspect all hoses for cracks and deterioration. Check for loose hose connections, defective hoses and gasket leaks.

TROUBLESHOOTING

Use the following "flow charts" as an aid to troubleshooting the cooling system.

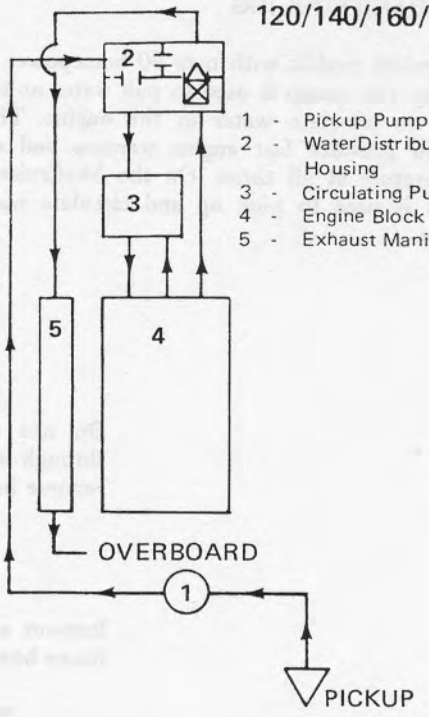
STANDARD COOLING SYSTEM - WATER FLOW

MERCRUISER 90 STERN DRIVE COOLING and DRAIN SYSTEM



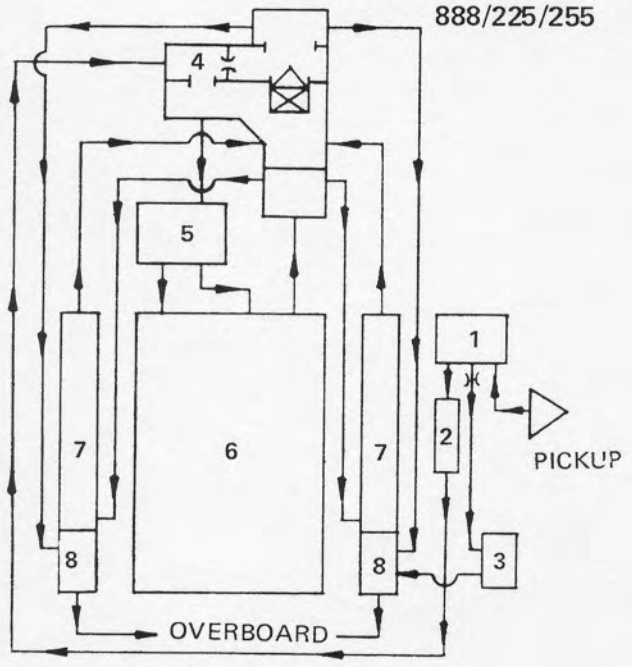
1 - Water Pump (in Stern Drive)
2 - Drain Valve
3 - Engine Block and Head
4 - Intake Manifold
5 - Thermostat Housing
6 - Exhaust Manifold and Elbow

MERCRUISER STERN DRIVE 120/140/160/165



1 - Pickup Pump
2 - WaterDistribution Housing
3 - Circulating Pump
4 - Engine Block & Head
5 - Exhaust Manifold

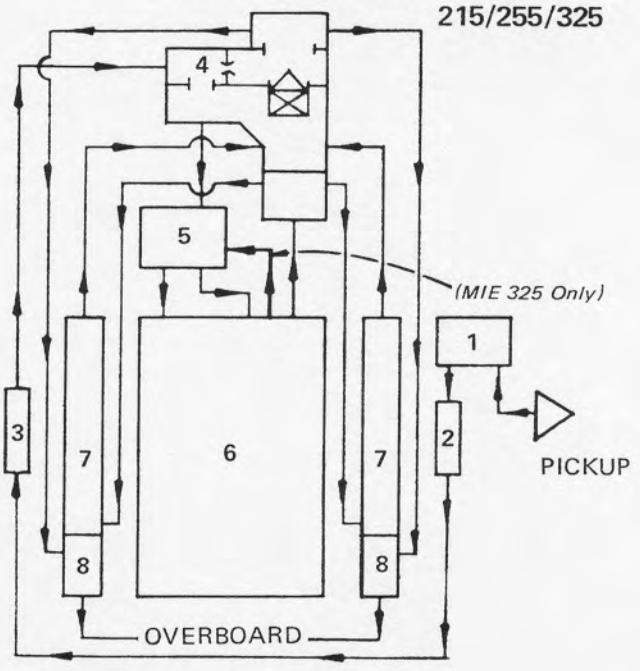
MERCRUISER STERN DRIVE 888/225/255



1 - Sea Water Pump▲
2 - Power Steering Oil Cooler▲▲
3 - Transmission Oil Cooler●
4 - Thermostat Housing
5 - Engine Circulating Pump
6 - Engine Block and Heads
7 - Exhaust Manifold
8 - Exhaust Elbow

▲*In Stern Drive on MCM 888*
▲▲*Optional on MCM 888*
●*MCM 225/255 Only*

MERCRUISER INBOARD ENGINE 215/255/325

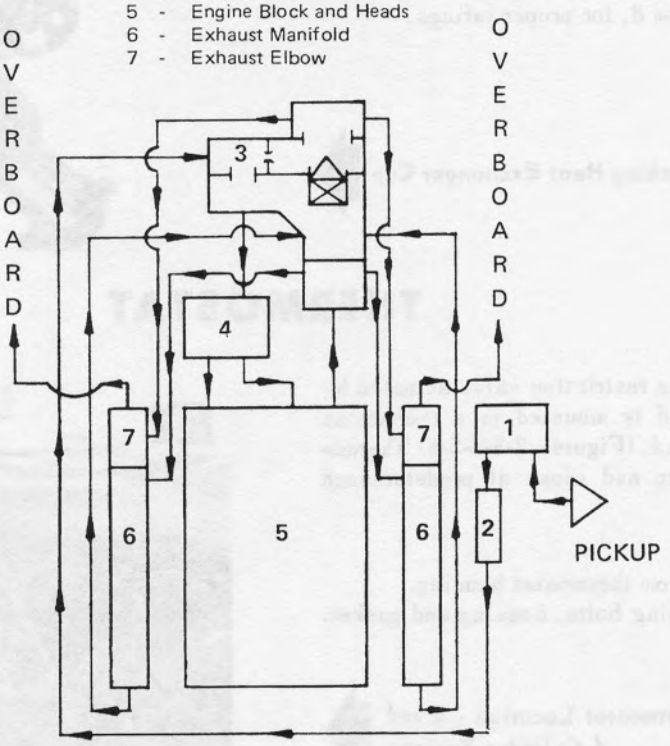


1 - Sea Water Pump
2 - Transmission Oil Cooler
3 - Engine Oil Cooler▲
4 - Thermostat Housing
5 - Engine Circulating Pump
6 - Engine Block and Heads
7 - Exhaust Manifold
8 - Exhaust Elbow

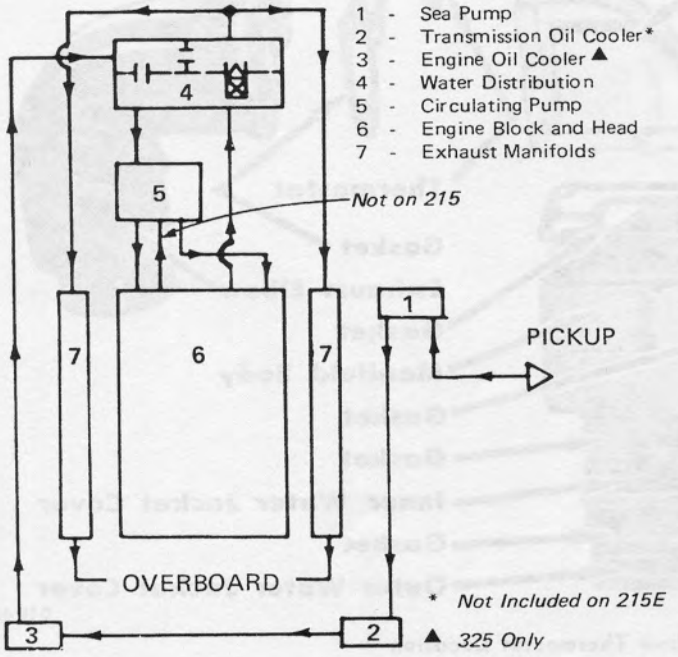
▲*MIE 325 Only*

MERCRUISER INBOARD ENGINE
215/255 V-DRIVE
(EXHAUST MANIFOLDS REVERSED)

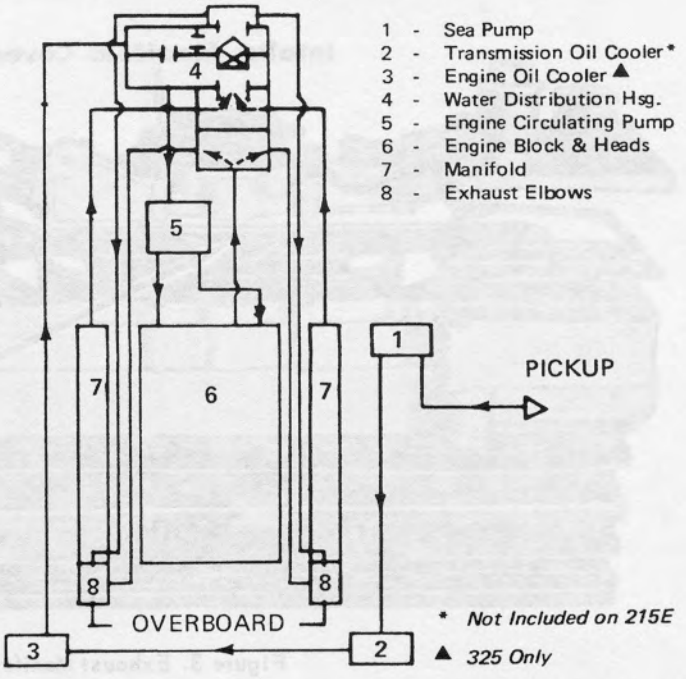
1 - Sea Water Pump
2 - Transmission Oil Cooler
3 - Thermostat Housing
4 - Engine Circulating Pump
5 - Engine Block and Heads
6 - Exhaust Manifold
7 - Exhaust Elbow



MERCRUISER 215-250-270-325



MERCRUISER STERN DRIVE and 215-250-270-325
HEATED MANIFOLD COOLING SYSTEM



HEAT EXCHANGER PRESSURE CAP

The pressure cap should be washed with clean water and pressure checked at regular tune-up intervals. Inspect rubber seal on cap for tears or cracks. Install cap on tester. (Figure 1) Replace pressure cap if it will not hold pressure or does not release at the proper pressure. Refer to "Specifications", Section 8, for proper ratings.

Figure 1. Pressure Checking Heat Exchanger Cap

THERMOSTAT

The thermostat consists of a restriction valve actuated by a thermostatic element and is mounted in a thermostat housing on the cylinder head. (Figures 2-3-4-5-6) Thermostats are designed to open and close at predetermined temperatures.

REPLACEMENT

1. Remove water hose(s) from thermostat housing.
2. Remove thermostat housing bolts, housing and gasket.

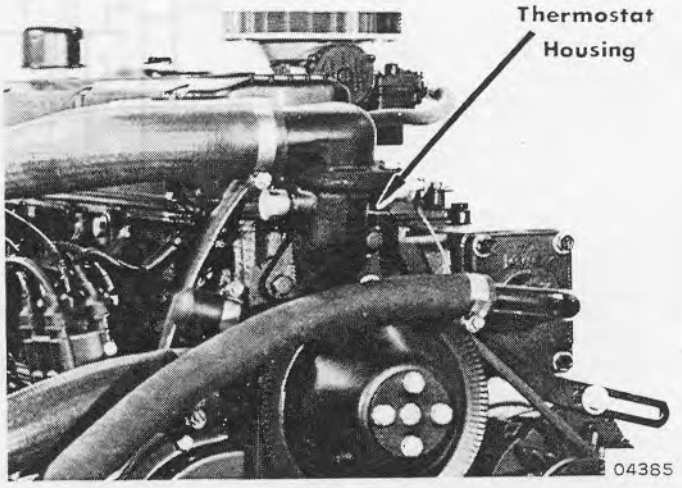


Figure 2. Thermostat Location - 4 and 6-Cylinder Engines

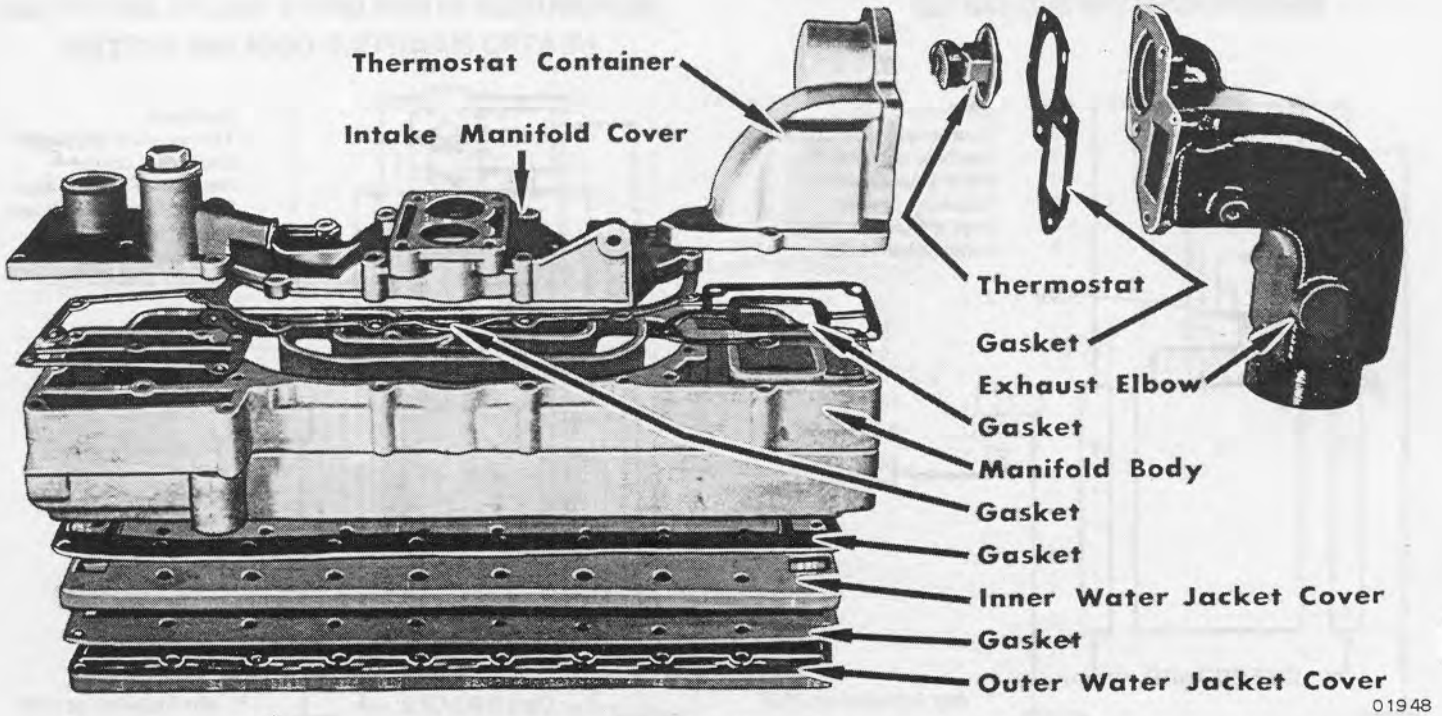


Figure 3. Exhaust Manifold Elbow Thermostat Location

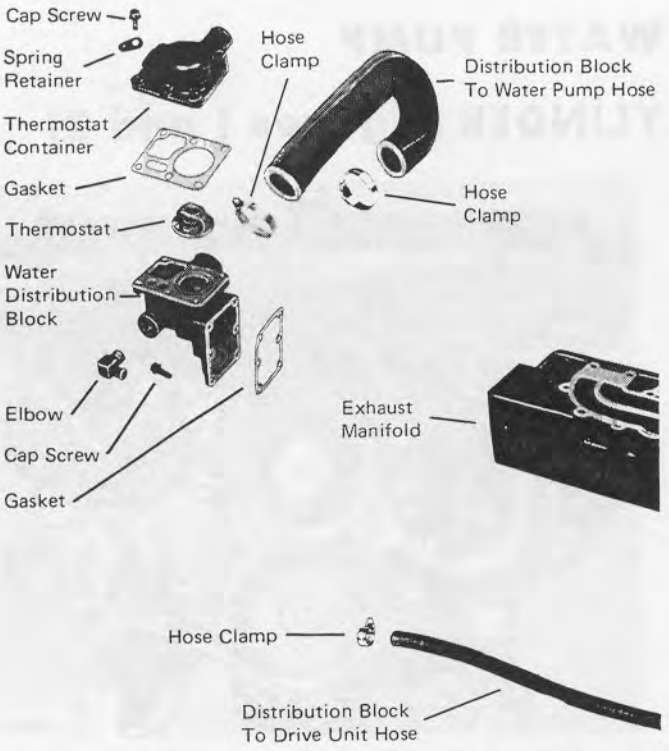


Figure 4. Exhaust Manifold End Cap Thermostat Location

3. Inspect thermostat valve to make sure that it is in good condition.

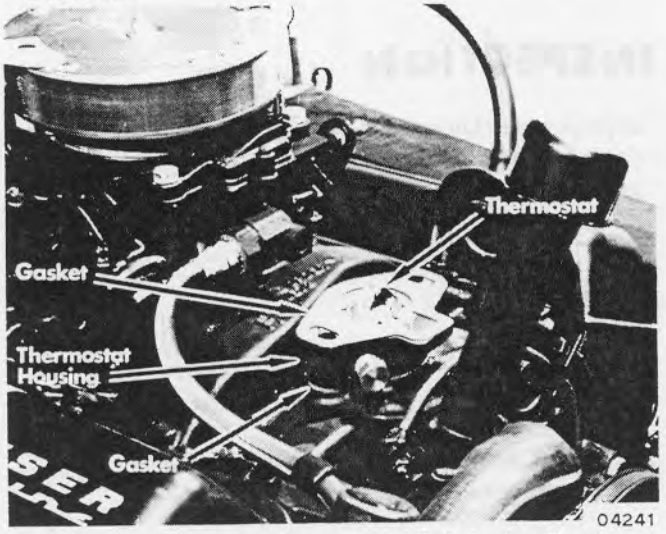


Figure 5. Thermostat Location - 8-Cylinder Engine

4. Place thermostat in hot water 25° above temperature stamped on thermostat valve.
5. Submerge valve completely and agitate water thoroughly. Valve should open fully.

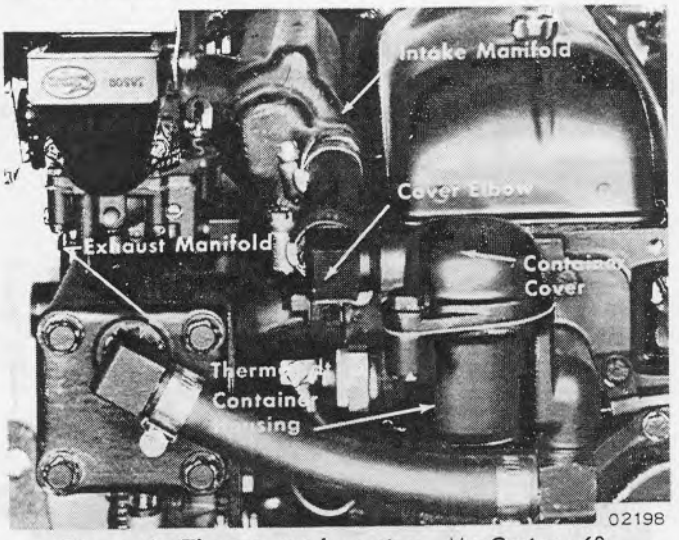


Figure 6. Thermostat Location - MerCruiser 60

6. Remove thermostat and place in water 10° below temperature indicated on valve. Valve should close completely.
7. If thermostat checks satisfactorily, re-install, using a new gasket. (Figure 7)

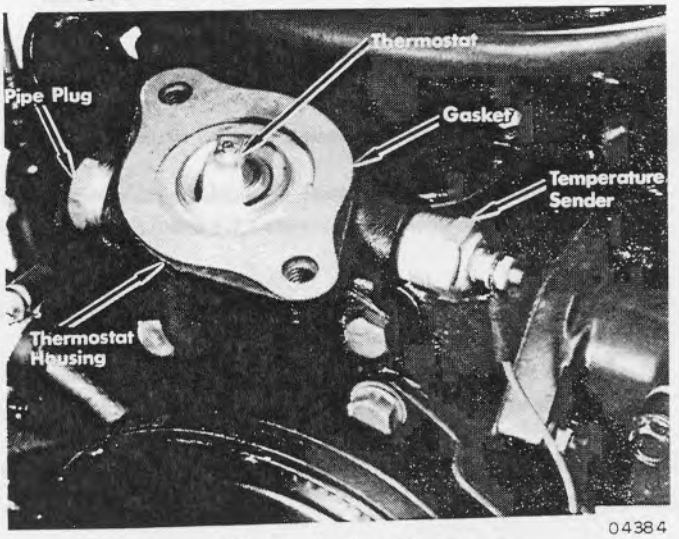


Figure 7. Replacing Thermostat

CIRCULATING WATER PUMP

REMOVAL - 4, 6 and 8 - CYLINDER (Figures 1 and 2)

1. Drain cooling system and break loose pulley bolts.
2. Disconnect large hose from pump. (Figure 1)
3. Loosen alternator upper brace and swivel bolt and remove drive belt.

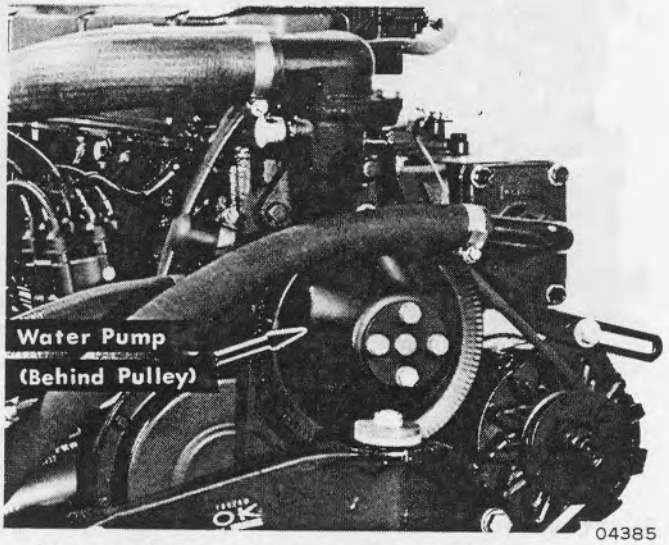


Figure 1. Water Pump Location - 4 and 6-Cylinder

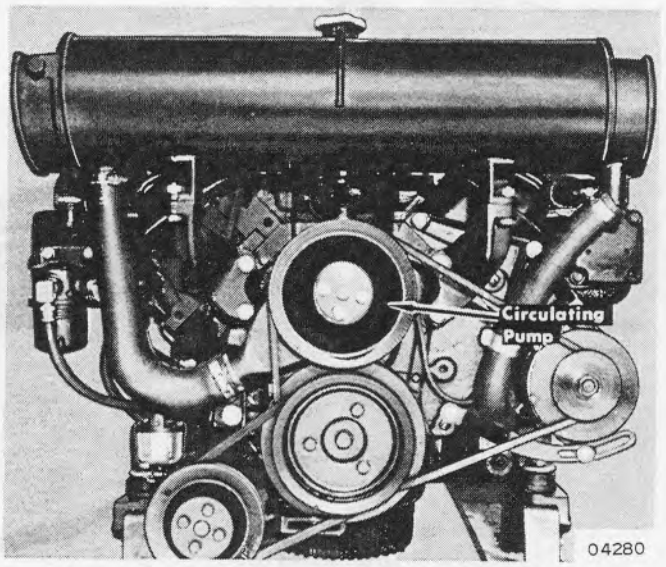


Figure 2. Water Pump Location - 8-Cylinder

4. Remove pulley attaching bolts and remove pulley.
5. Remove pump to cylinder block bolts and remove pump and old gasket from engine.

CLEANING and INSPECTION

1. Clean gasket mounting surfaces of water pump and cylinder block.
2. Clean and inspect seal seating surface of water pump.
3. Clean pump housing and inspect for cracks, sand holes, improper machining and damaged surfaces. If water pump housing is damaged beyond repair, replace complete water pump.

INSTALLATION

1. Install pump assembly on cylinder block, then (using a new sealer-coated pump to block gasket) tighten bolts to specifications.
2. Install pump pulley and tighten bolts to specifications.
3. Connect hoses and fill cooling system.
4. Install drive belt and tighten alternator upper brace and swivel bolt.
5. Adjust drive belt to specifications.
6. Start engine and check for leaks.

DRAINING INSTRUCTIONS
MERCRUISER "60" with FRESH WATER COOLING

DRAINING FRESH WATER SECTION of COOLING SYSTEM

1. Remove cap from heat exchanger.

> **CAUTION:** Heat exchanger is equipped with a 7 or 14 lb. pressure cap. To remove cap, turn a quarter (¼) of a turn to allow pressure in cooling system to escape, then turn cap all-the-way off.

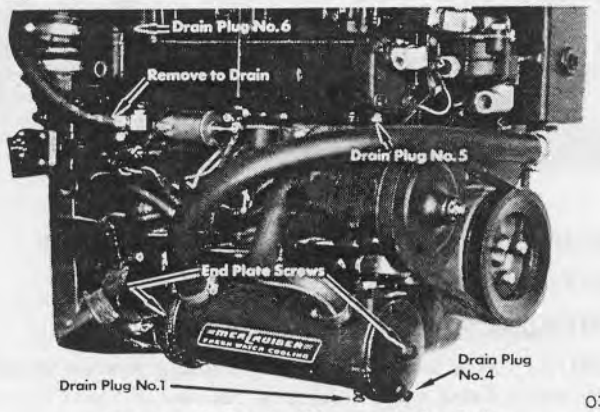


Figure 1. Drain Plugs, Right Side

2. Remove drain plug No. 1 on bottom of heat exchanger. (Figure 1)
3. Remove drain plug No. 2 from 180° elbow fitting. (Figure 2)
4. Remove drain plug No. 3 from engine block. (Figure 2)
5. IF POSSIBLE, place a container under drains to prevent water from draining into boat.
6. When fresh water section has been drained thoroughly, place Perfect Seal No. 4 (C-92-34227) on threads of plugs, reinstall and tighten securely. Replace filler cap if not filling system.

DRAINING SEA WATER SECTION of COOLING SYSTEM

1. Remove drain plug No. 4 on heat exchanger.
2. Remove drain plug No. 5 & No. 6 on exhaust manifold.

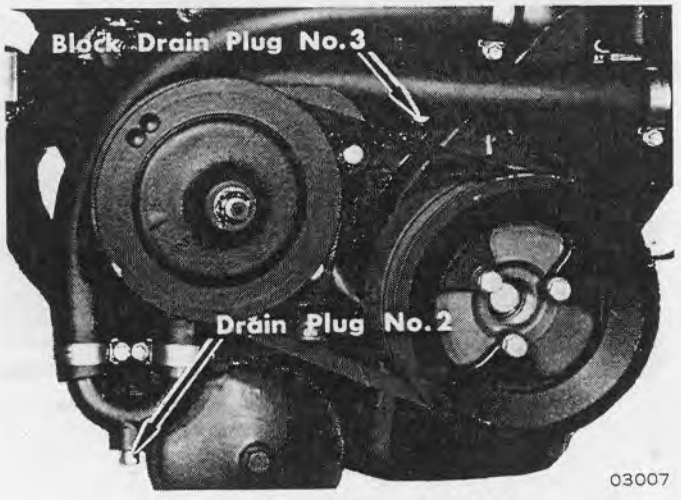


Figure 2. Drain Plugs, Left Side

3. Remove hose from elbow fitting on bottom of exhaust manifold.
4. IF POSSIBLE, place a container under drains to prevent water from entering boat.
5. When sea water section has been drained thoroughly. place Perfect Seal No. 4 (C-92-34227) on threads of plugs, reinstall and tighten securely.
6. Reinstall hose and clamp.

CLEANING SEA WATER SECTION of EXCHANGER

NOTE: It will be necessary to remove heat exchanger from engine to properly clean it. Mark end plates before removing.

1. Remove screws, which fasten end plates to exchanger, and remove plates. (Figure 1)
2. Clean water passages by inserting a suitable size brush thru them. (Figure 3)
3. Coat both sides of new end plate gasket with Perfect Seal No. 4 (C-92-34227) and place gasket in position on exchanger.
4. Place end plates in position on exchanger.
5. Place one new sealing washer on each end plate attaching screw and thread screw thru plate into exchanger. Tighten screw securely.
6. Reinstall heat exchanger to engine.
7. Fill system, according to procedure, and operate engine. Check for leaks.

MAINTENANCE

NOTE: Fresh water section of cooling system should be drained and filled with new coolant at least once a year. Refer to draining and filling instructions.

1. It is recommended that coolant level of heat exchanger be checked periodically and coolant added as necessary.
2. If coolant level is excessively low, cooling system should be checked for leaks and repaired as necessary.
3. Normal coolant level is 1" (25.4mm) below top of exchanger. If exchanger is over-filled, excess coolant will flow out overflow pipe when engine reaches operating temperature.

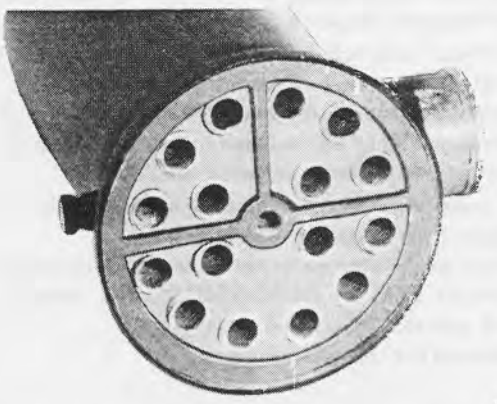


Figure 3. Water Passages - MerCruiser "60"

DRAINING INSTRUCTIONS

4 and 6-CYLINDER ENGINES with FRESH WATER COOLING

DRAINING FRESH WATER SECTION of COOLING SYSTEM

1. Remove cap from heat exchanger.

> **CAUTION: Heat exchanger is equipped with a 14 pound pressure cap. To remove cap, turn a quarter of a turn to allow pressure in cooling system to escape. Then turn cap all the way off.**

2. Remove drain plug (Figure 4) near bottom of exchanger.

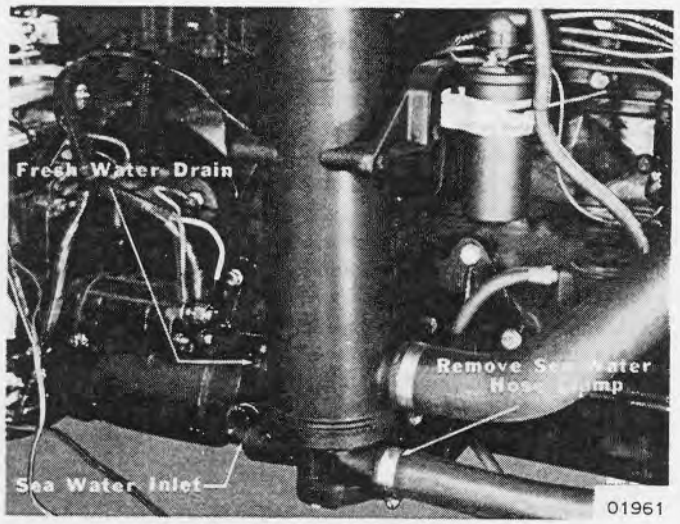


Figure 4. Removing Drain Plug

3. Remove drain plug from cylinder block. Plug is located on side of cylinder block. (Figure 5)
4. If possible, place a container under drains to prevent water from draining into boat.
5. When fresh water section has drained thoroughly, place Perfect Seal No. 4 (C-92-34227) on threads of plugs and reinstall. Tighten securely.

DRAINING SEA WATER SECTION of COOLING SYSTEM

1. Remove drain plugs from bottom of manifold and heat exchanger. (Figures 5 and 6)
2. Loosen hose clamp (Figure 4) and remove hose from heat exchanger.
3. Remove water inlet hose from inlet side of heat exchanger. Plug end of hose, using a suitable plug, to prevent water from entering boat.
4. If possible, place a container under drains to prevent water from draining into boat.
5. When sea water section has drained thoroughly, place Perfect Seal No. 4 (C-92-34227) on threads of plugs and reinstall. Tighten securely.
6. Reinstall hose and clamps.

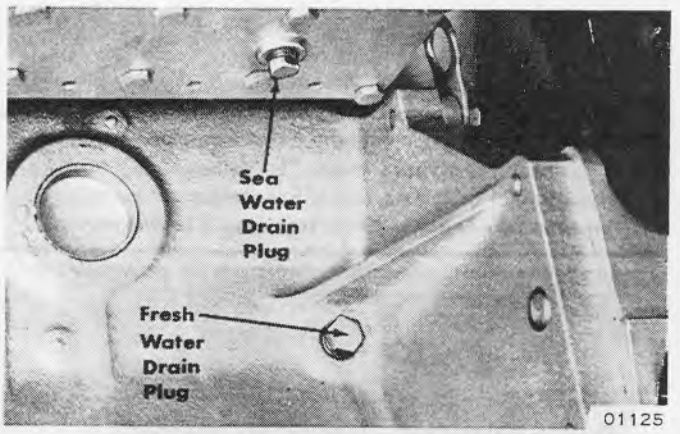


Figure 5. Engine Drain Plugs

CLEANING SEA WATER SECTION of EXCHANGER

Refer to MerCruiser 60 instructions, preceding.

MAINTENANCE

NOTE: Fresh water section of cooling system should be drained and filled with new coolant at least once a year. Refer to draining and filling instructions, preceding.

1. It is recommended that coolant level of heat exchanger be checked periodically and coolant added as necessary.
2. If coolant level is excessively low, cooling system should be checked for leaks and repaired as necessary.
3. Normal coolant level is ½" (12.7mm) below top of exchanger. If exchanger is over-filled, excess coolant will flow out overflow pipe when engine reaches operating temperature.

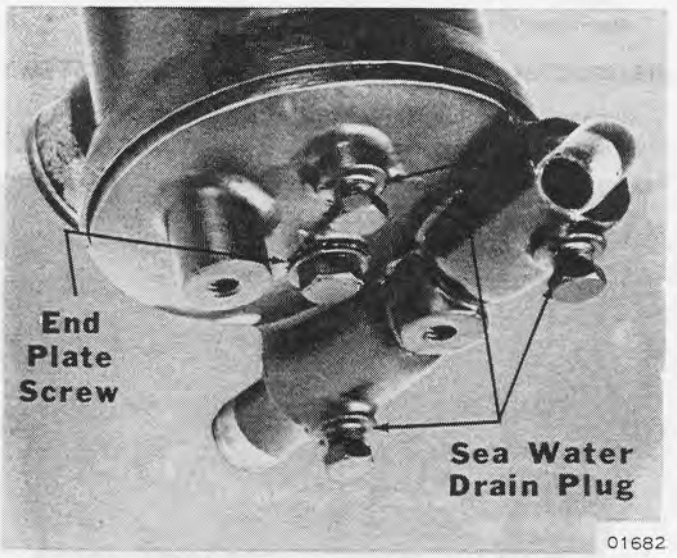


Figure 6. Sea Water Drain Plugs - Exchanger

DRAINING INSTRUCTIONS
8-CYLINDER ENGINES with FRESH WATER COOLING

DRAINING FRESH WATER SECTION of COOLING SYSTEM

1. Remove cap from heat exchanger.
2. Remove drain plug ("A" in Figure 1) from bottom of exchanger.
3. Remove drain plug from manifolds and cylinder block. One plug is located in the bottom of each manifold and one plug is located on each side of cylinder block. (Figure 2)

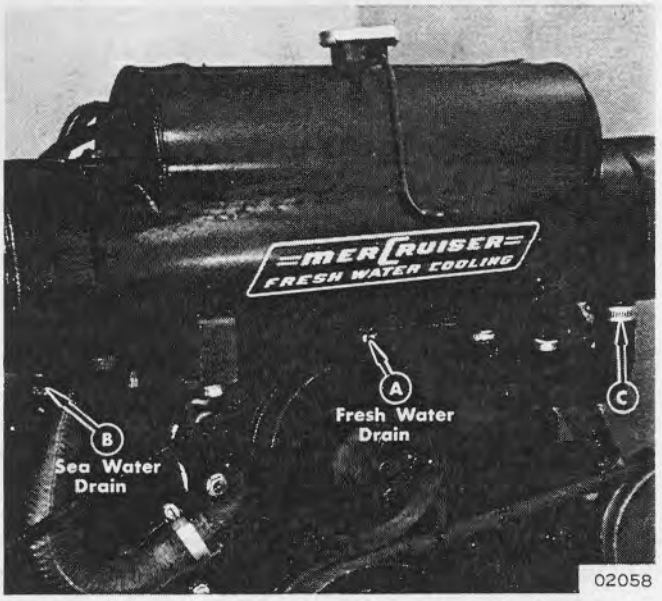


Figure 1. Drain Locations - Heat Exchanger for 190 and 225

DRAINING SEA WATER SECTION of COOLING SYSTEM

1. Remove drain plug ("B" in Figure 1) from bottom of heat exchanger.
2. Loosen hose clamp ("C" in Figure 2) and remove hose from heat exchanger.
3. Remove water inlet hose from inlet side of sea water pump. Plug end of hose, using a suitable plug, to prevent water from entering boat.

CLEANING SEA WATER SECTION of EXCHANGER

Refer to MerCruiser 60 instructions, preceding.

IMPORTANT: Starboard and port end plates are not interchangeable. (Figure 3) Alignment marks on plates must line up as shown in Figure 5 and Figure 6. Make sure that gaskets are positioned correctly.

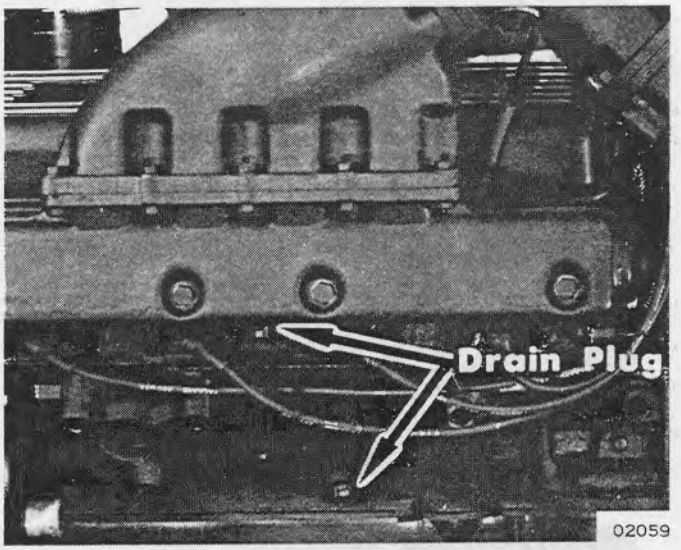


Figure 2. Engine Drain Plug Locations for 190 and 225, Shown (Same Locations on Starboard Side)

Figure 3. End Plate - Starboard Side Shown

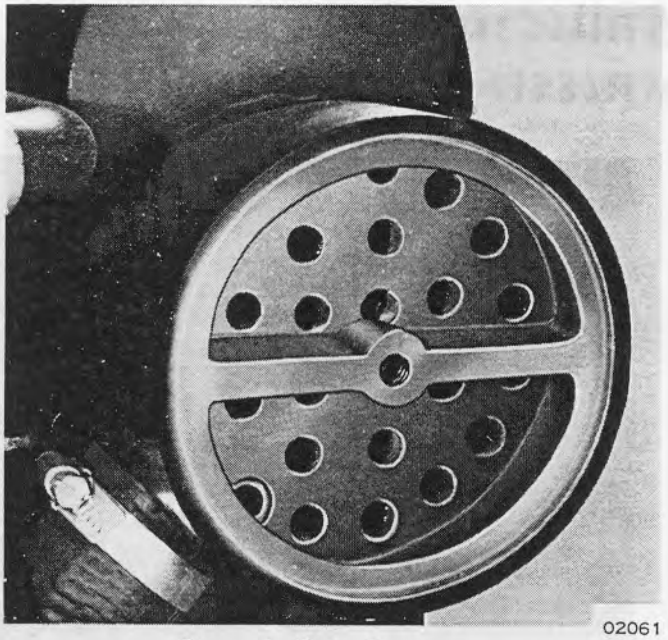


Figure 4. Water Passages

Figure 5. End Plate Installed - Starboard Side

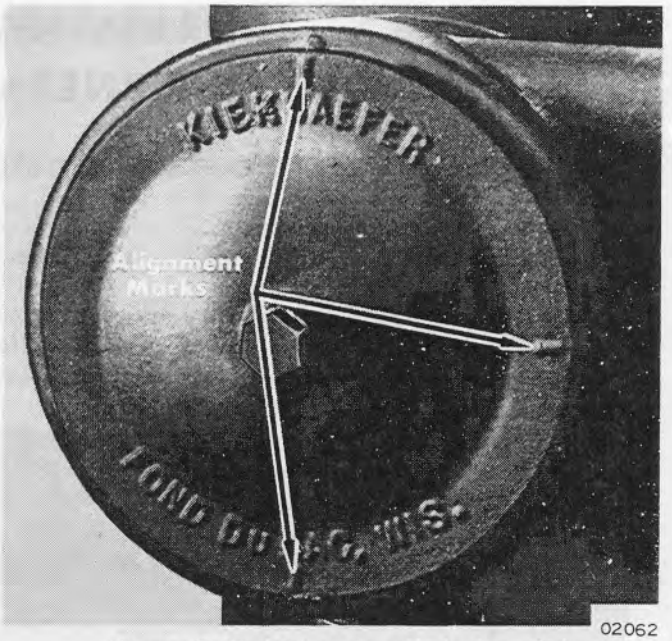


Figure 6. End Plate Installed - Port Side

MAINTENANCE

NOTE: Fresh water section of cooling system should be drained and filled with new coolant at least once a year. Refer to draining and filling instructions.

1. It is recommended that coolant level of heat exchanger be checked periodically and coolant added as necessary.
2. If coolant level is excessively low, cooling system should be checked for leaks and repaired as necessary.
3. Normal coolant level is 1" (25.4mm) below top of exchanger. If exchanger is over-filled, excess coolant will flow out overflow pipe when engine reaches operating temperature.

CAUTION: Heat exchanger is equipped with a 7 pound pressure cap. To remove cap, turn a quarter of a turn to allow pressure in cooling system to escape. Then turn cap all the way off.

FILLING COOLING SYSTEM - ALL MODELS

NOTE: Refer to "Specifications" Section 8 for cooling system capacities.

ENGINE NOT EXPOSED TO FREEZING TEMPERATURES

CAUTION: If engine will not be exposed to freezing temperatures, fill cooling system with a mixture of clean, soft water and an automotive cooling system rust inhibitor mixed to proportions recommended by inhibitor manufacturer. If unable to obtain soft water, hard water may be used. However, in some areas, hard water may have a high mineral content which may cause scale and deposits to collect on internal parts of cooling system.

1. Remove cap and fill heat exchanger with water. Allow enough space to add rust inhibitor.
2. Add rust inhibitor, using quantity recommended by inhibitor manufacturer.
3. Start engine and run at idle.

CAUTION: Do not operate engine without cooling water flowing through sea water pump, or pump will be damaged.

4. Add water to exchanger, while engine is running, until water level is 1" below top of exchanger for MerCruiser 60, 80, 90, 190 and 225 and ½" (12.7mm) below top for MerCruiser 110, 120, 140, 150, 160 and 165. Install cap.
5. Check all hose connections, fittings and manifolds for water leaks while engine is running. Also observe water temperature gauge. Engine temperature should not exceed 180° F (82° C).

ENGINE EXPOSED TO FREEZING TEMPERATURES

CAUTION: If engine will be exposed to freezing temperatures, fill cooling system with a mixture of clean, soft water and permanent type anti-freeze mixed to proportions recommended by anti-freeze manufacturer for the lowest temperature to which engine will be exposed. If unable to obtain soft water, hard water may be used. In some areas, however, hard water may have a high mineral content which may cause scale and deposits to collect on internal parts of cooling system.

NOTE: Alcohol or methanol base coolants or plain water are not recommended for your engine at any time.

If engine is operated during a period of time when the possibility of freezing temperatures no longer exists, anti-freeze and water mixture should be drained from system and system filled with a mixture of water and rust inhibitor as outlined under "Filling Cooling System - Engine Not Exposed to Freezing Temperatures", preceding. The reason is that, as a coolant, the anti-freeze and water mixture is not as efficient as 100 percent water, and engine operating temperature will increase when operated during periods of higher temperatures.

1. Before filling system, torque cylinder head bolts and all manifold screws to specifications.
2. Remove exchanger cap and fill system with clean, soft water and permanent type anti-freeze mixed to proportions recommended by anti-freeze manufacturer for the lowest temperature to which engine will be exposed. If unable to obtain soft water, hard water may be used. In some areas, however, hard water may have a high mineral content which may cause scale and deposits to collect on internal parts of cooling system.
3. Start engine and run at idle.

CAUTION: Do not operate engine without cooling water flowing through sea water pump, or pump will be damaged.

4. Add remainder of mixture to exchanger while engine is running, measuring amount required to bring level 1" below top of exchanger for MerCruiser 190 and 225 and ½" (12.7mm) below top of reservoir for MerCruiser 110, 120, 140, 150, 160 and 165.
5. Stop engine and determine amount of anti-freeze required according to the anti-freeze manufacturer's recommendation for the volume of the cooling system.
6. Remove drain plug, located on side of cylinder block, and allow a sufficient volume of water to drain from engine so that anti-freeze can be added. Replace plug and tighten securely .
7. Add anti-freeze to exchanger. If anti-freeze does not bring water level to 1" below top of exchanger, add water as required.
8. Start engine and run at idle.
9. Add water to exchanger, while engine is running, until water level is 1" (25.4mm) below top of exchanger. Install cap.
10. Check all hose connections, fittings and manifolds for water leaks while engine is running. Also observe water temperature gauge. Engine temperature should not exceed 180° F (82° C).

NOTE: Refer to "Specifications" Section 8 for cooling system pressures.

WATER PICKUP PUMP B-46-32901A2 - V-8 ENGINE

REMOVAL (Refer to Figure 2)

1. Loosen adjustment bracket and remove drive belt.
2. Before removing water inlet hose, some provision must be made to either plug the hose or raise it above water level to prevent water from entering the boat.
3. Remove inlet and outlet hoses.
4. Remove 2 screws which secure water pump to mounting brackets.

DISASSEMBLY

1. Remove drive pulley by removing lock nut and set screw which secure pulley to impeller shaft.
2. Remove key and spacer from impeller shaft.
3. Remove 3 screws which hold pump housings together.
4. End plate ca be removed by tapping lightly with rawhide mallet.
5. Remove impellers and drive pins by lifting out carefully with 2 screwdrivers.
6. Remove drive shaft.
7. Remove snap ring from front (drive end) plate and press bearing out.
8. Remove oil seals.
9. Remove welch plug from rear (opposite drive end) plate.
10. Remove snap ring and press bearing out.
11. Remove oil seals.

INSPECTION

1. Inspect impellers, inserts and stainless steel face plates for possible wear or damage.
2. Inspect bearings for possible wear or roughness. Oil seals cannot be reused after removal.

CAUTION: MerCruiser 200 Engine sea water pumps have a plastic restrictor (B-19-52153) with a ½" (12.7mm) hole installed in pump inlet when engine is shipped from factory. Be certain that the restrictor is left in pump inlet, since it regulates the cooling water volume and pressure. If the restrictor is removed, cooling system damage may result. In several cases, cooling system hoses have blown off because of excessive pressure when restrictor was not used.

REASSEMBLY (Refer to Figure 2)

NOTE: When installing or replacing water pump body inserts on units used in salt water areas, apply a thin coat of Crankcase Sealer (C-92-28804) to outside of cup before inserting into body. Wipe off excess sealer after installing insert into water pump body. This will eliminate salt or corrosion build-up between the insert and water pump body.

1. Oil seals are installed with lips facing toward impellers. Press inner seals firmly against shoulders. Outer seals are pressed 1/32" deep, and care must be taken to prevent restriction of water bleed holes.
2. Press bearings into end plates and install snap rings.
3. Install welch plug in rear (opposite drive end) plate.
4. Install impeller shaft in front (drive end) plate and clamp drive end of impeller shaft in vise.
5. Install gaskets and stainless steel face plate in proper sequence on front plate. Use 3 water pump housing screws to keep parts in alignment.

   NOTE: Face plates B-32836 and B-32837 have a small tab which aligns with alignment hole in water pickup pump body to prevent incorrect assembly. When matching late style face plates with earlier style water pickup pump bodies, which do not have the alignment hole, it will be necessary to bend the tab flat before assembling. (Figure 1)

6. Install impeller drive key and impeller on impeller shaft.
7. Place water pump bearings together and slide down over 3 screws.
8. Rotate housing to slide over impeller.
9. Install impeller drive key and impeller in upper housing.
10. Install gaskets and stainless steel face plate in proper sequence on upper housing.
11. Install rear end plate and 3 nuts and tighten evenly.

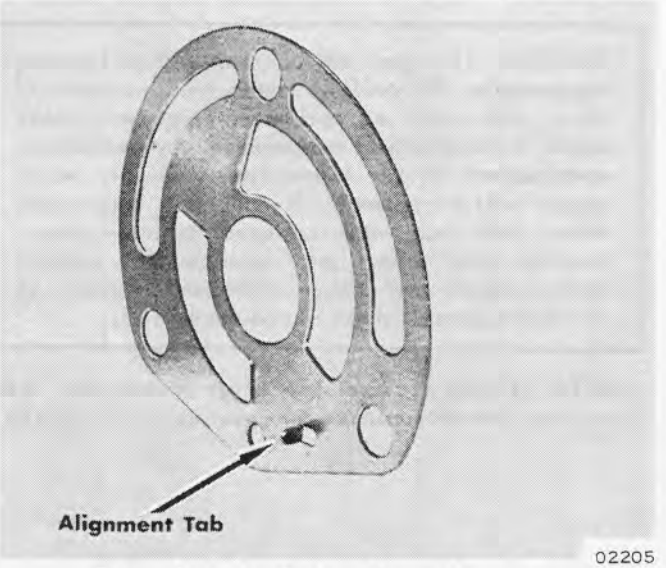


Figure 1. Water Pickup Pump Alignment

12. Install spacer, drive key, pulley, washer and nut.
13. Tighten nut securely, then tighten set screws.

INSTALLATION

1. Install mounting screws and align drive belt by placing straight edge across outside flange of pulleys. Use washers, as necessary, for proper alignment.
2. Install inlet and outlet hoses.
3. Install drive belt.
4. Install adjustment bracket screw and adjust belt.
5. Start engine and check for possible water leaks.

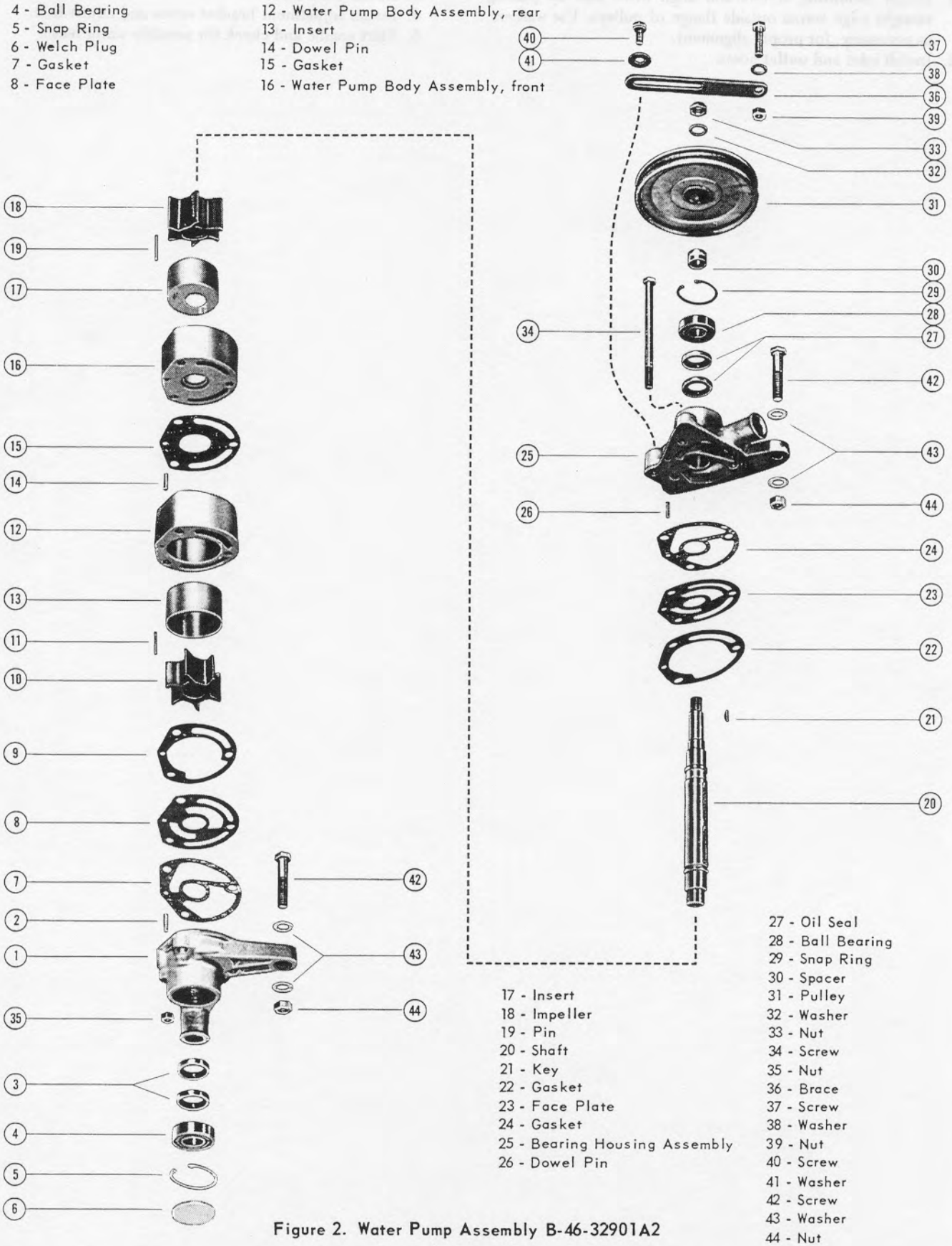


Figure 2. Water Pump Assembly B-46-32901A2

WATER PUMP B-46-39750A2 (MERCRUISER 60)

REMOVAL

1. Drain cooling system.(Figure 3)
2. Disconnect water pump inlet and outlet hoses. (Figure 4)
3. Loosen water pump upper brace and swivel bolt and remove drive belt.

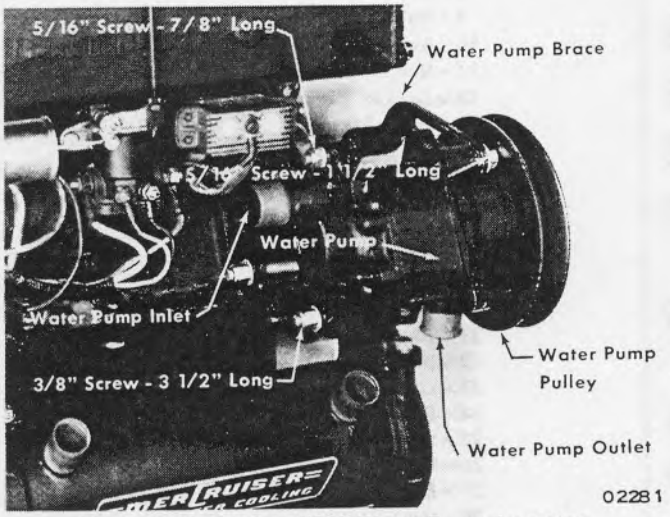


Figure 3. MerCruiser "60" Water Pump Location

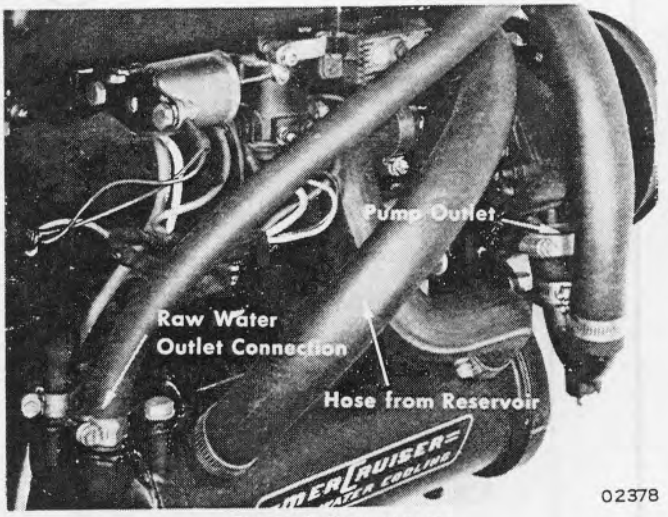


Figure 4. Pump Hoses

4. Remove pulley attaching bolt and remove pulley. (Figure 1)
5. Remove pump to pump bracket bolts and remove pump from engine. (Figure 1)

DISASSEMBLY (Refer to Figure 5)

1. Remove water pump pulley nut and remove washer and pulley.
2. Remove 3 thru bolts and nuts and separate water outlet housing end from pump body assembly with a rawhide mallet.
3. Remove impeller and pin from drive shaft.
4. Bearings and oil seals may be pressed from housing ends and replaced.
5. Refer to Figure 5 for further disassembly.

REASSEMBLY (Refer to Figure 5)

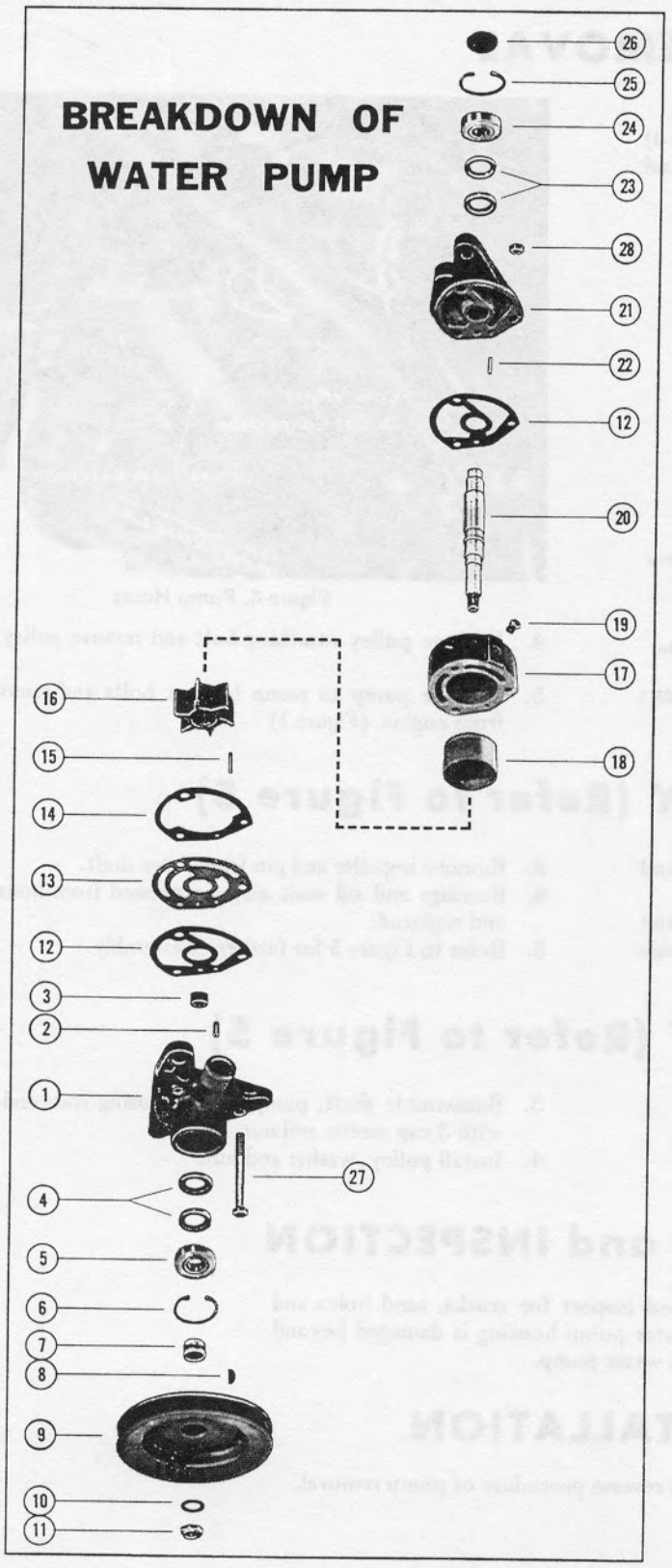
1. Replace seals and gaskets in pump housing.
2. Install bearings in housing ends.
3. Reassemble shaft, pump body, housing ends and impeller with 3 cap screws and nut.
4. Install pulley, washer and nut.

CLEANING and INSPECTION

Clean pump housing and inspect for cracks, sand holes and damaged surfaces. If water pump housing is damaged beyond repair, replace complete water pump.

INSTALLATION

Pump installation is reverse procedure of pump removal.



1 - Bearing Housing Assembly
2 - Dowel Pin
3 - Bushing
4 - Oil Seal
5 - Ball Bearing
6 - Snap Ring
7 - Spacer
8 - Key
9 - Pulley
10 - Washer
11 - Nut
12 - Gasket
13 - Face Plate
14 - Gasket
15 - Pin
16 - Impeller
17 - Water Pump Body Assembly
18 - Insert
19 - Pipe Plug
20 - Drive Shaft
21 - Bearing Housing Assembly
22 - Dowel Pin
23 - Oil Seal
24 - Ball Bearing
25 - Snap Ring
26 - Welch Plug
27 - Bolt
28 - Nut

Figure 5. Water Pump Assembly B-46-39750A2

WATER PICKUP PUMP - B-46-47506A1

REMOVAL

1. Loosen adjustment bracket and remove drive belt.
2. Before removing water inlet hose, either plug the hose or raise it above water level to prevent water from entering boat.
3. Remove inlet and outlet hoses.
4. Remove water pump bracket to alternator bracket screw and remove water pump.

DISASSEMBLY (Figure 6)

1. Remove 4 water pump pulley screws and remove water pump pulley.
2. Loosen water pump bracket clamping screw and remove bracket
3. Remove 6 screws and remove end plate, gasket and wear plate. End plate can be removed by tapping lightly with rawhide mallet.
4. Using 2 screwdrivers, remove impeller and pin.
5. Remove water pump body insert and wear plate.
6. Press shaft and bearings out of pump body.
7. Remove oil seal from pump body.

REASSEMBLY

1. Replace seal in pump body.
2. Insert shaft and bearing into pump body.
3. Press pulley hub on shaft.
4. Insert wear plate, pump body insert, pin and impeller.
5. Install top wear plate, gasket and end plate with 6 screws.
6. Install mounting bracket.
7. Attach pulley to pump with 4 screws and lockwashers.

INSTALLATION

Pump installation is reverse procedure of pump removal.

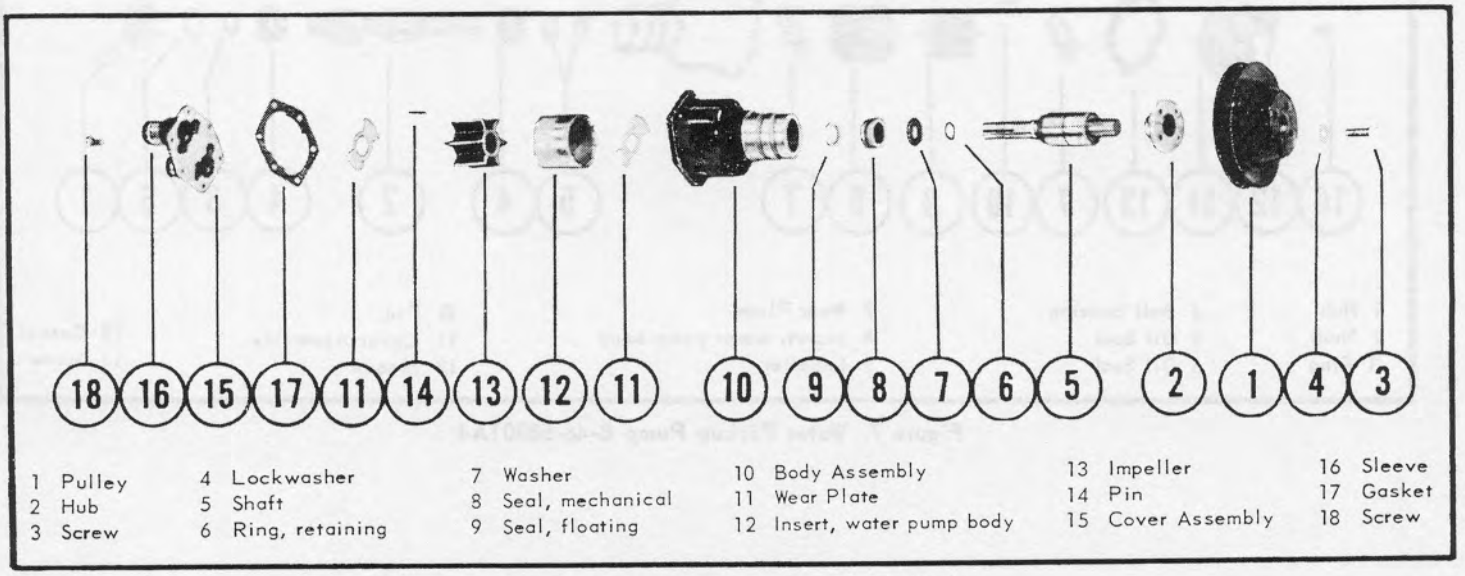


Figure 6. Water Pickup Pump B-46-47506A1

WATER PICKUP PUMP - B-46-58001A4

REMOVAL

1. Loosen adjustment bracket and remove drive belt.
2. Before removing water inlet hose, either plug the hose or raise it above water level to prevent water from entering boat.
3. Remove inlet and outlet hoses.
4. Remove water pump bracket to alternator bracket screw and remove water pump.

DISASSEMBLY (Figure 7)

1. Remove 4 water pump pulley screws and remove water pump pulley.
2. Loosen water pump bracket clamping screw and remove bracket.
3. Remove 6 screws and remove end plate, gasket and wear plate. End plate can be removed by tapping lightly with rawhide mallet.
4. Using 2 screwdrivers, remove impeller and pin.
5. Remove water pump body insert and wear plate.
6. Pull pulley hub and remove oil seal.
7. Remove retaining ring.
8. Press shaft and bearings out of pump body.
9. Remove 2 oil seals from pump body.

REASSEMBLY

1. Replace seals in pump body.
2. Insert shaft and bearing into pump body.
3. Insert ring retainer.
4. Install oil seal.
5. Press on pulley hub.
6. Insert wear plate, pump body insert pin and impeller.
7. Insert top wear plate, gasket end plate assembly and 6 screws.
8. Install mounting bracket.
9. Attach pulley to pump with 4 screws and lockwashers.

INSTALLATION

Pump installation is reverse procedure of pump removal.

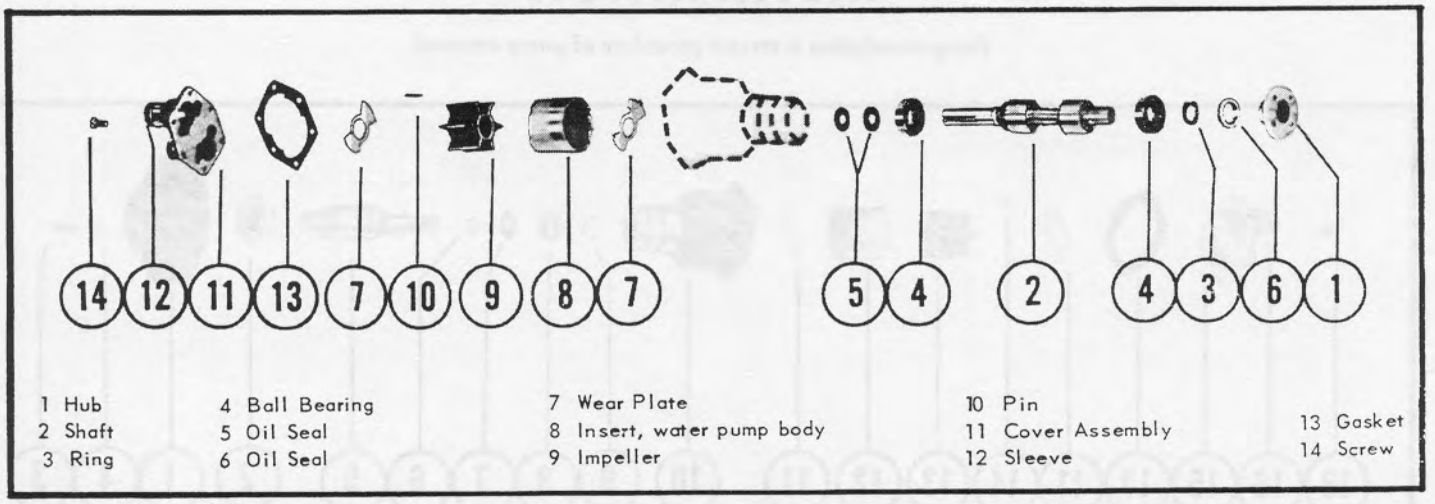


Figure 7. Water Pickup Pump B-46-58001A4

HIGH CAPACITY WATER PUMP ASSEMBLY B-46-59112A3

REMOVAL

CAUTION: If boat is in water when removing water inlet hose, either plug the hose or raise it above water level to prevent water from entering boat.

1. Loosen adjustment bracket and remove drive belt.
2. Remove inlet and outlet hoses.
3. Remove water pump bracket to alternator bracket screw and remove water pump.

DISASSEMBLY

1. Remove 6 hex head cap screws and remove water pump body cover and "O" ring.
2. Remove cam screw and pull cam from pump body. (Figure 1) Note pin position.
3. Remove plug from end of impeller. Using appropriate tool, remove impeller, 2 drive keys and wear plate.
4. Remove 4 cap screws from water pump pulley and remove pulley.
5. Press pulley hub off with a plate and arbor press.
6. Using an appropriate tool, remove oil seal. Note that oil seal will be damaged in removal and must be replaced.
7. Remove snap ring and press water pump shaft from output end of pump body. (Figure 2) Note position of oil seal lips. Lips must face impeller during reassembly.
8. Using a slide hammer puller, remove ball bearing if it remains inside pump body.
9. Remove 2 oil seals from pump body with appropriate tool.

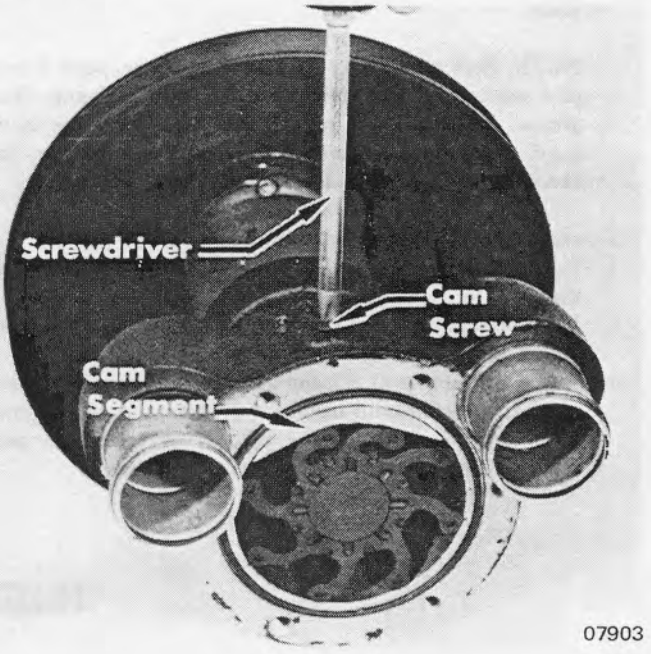


Figure 1. Removing Cam Segment Screw

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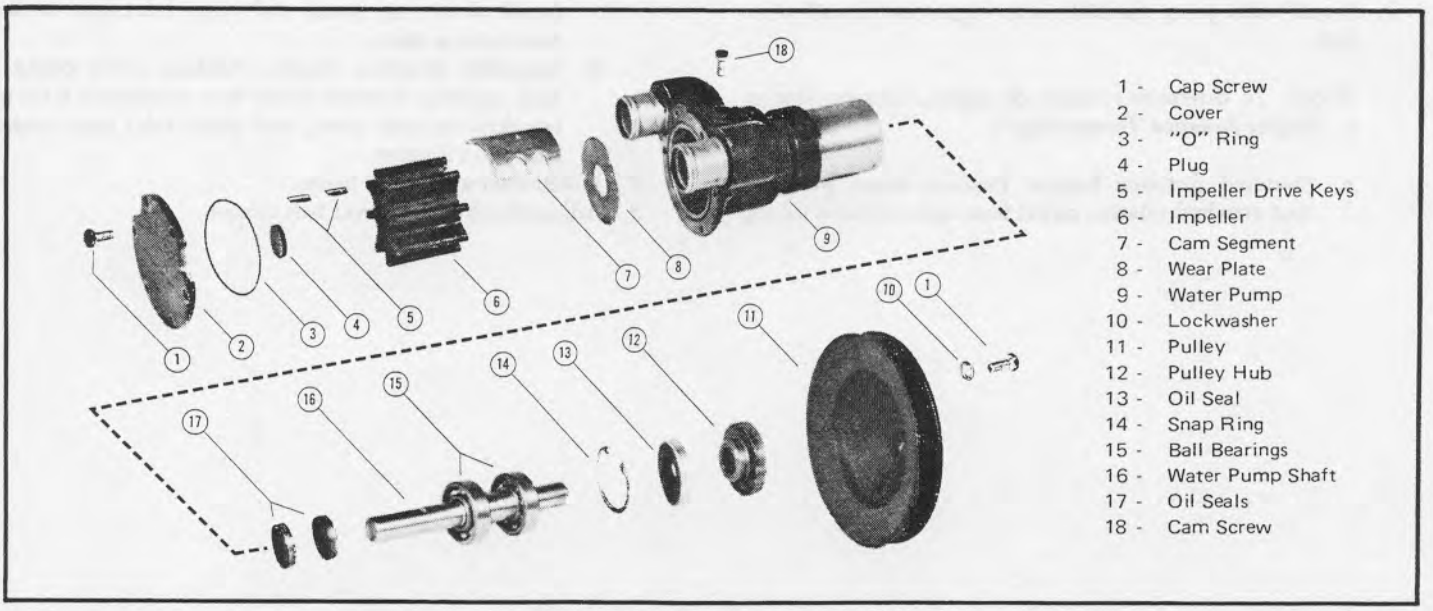


Figure 2. Water Pump, Exploded View

REASSEMBLY

1. Install two oil seals into pump body with lips facing impeller end (the first oil seal bottomed-out, the second seal flush with pump housing). Apply a thin film of Loctite Type "A" (C-92-32609) on oil seal outside diameter during installation. Pack seal cavity with Shell Alvania No. 3 grease, if available. If not available, use Multipurpose Lubricant (C-92-63250), but Multipurpose should not be used when continuous high-speed, heavy-duty use will be encountered.
2. Install water pump shaft and inside ball bearing into pump body.

   NOTE: Before installing outside ball bearing, pack bearings and cavity between bearings with Shell Alvania No. 3 grease, if available. If not available, Multipurpose may be used, but it should not be used when continuous high-speed, heavy-duty use will be encountered.

3. Install outside ball bearing and snap ring.
4. Using an appropriate tool, install oil seal (lips must face out).
5. Press pulley hub onto water pump shaft so that hub end is ¼" (6.35mm) from pump shaft end.
6. Apply a thin film of silicone seal to back side of wear plate and cam segment and install wear plate and cam segment. Cam segment pin must be placed into recess in pump body. (Figure 3) Secure cam segment with screw.

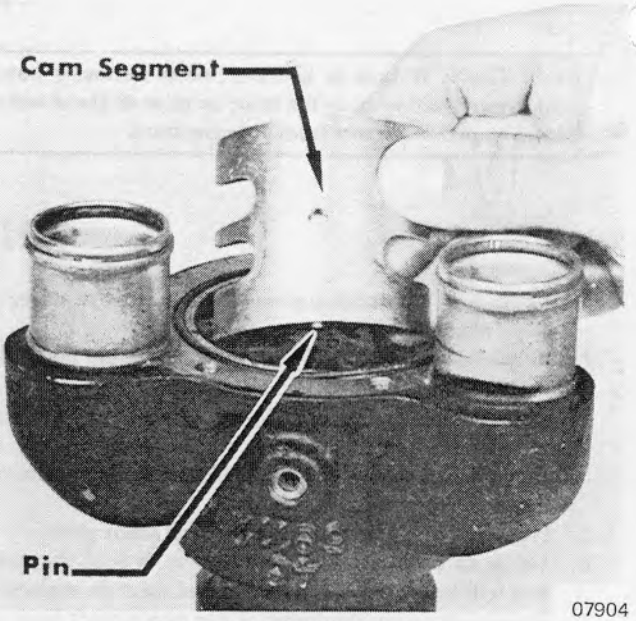


Figure 3. Cam Segment Pin

7. Install impeller, 2 drive keys, plug, "O" ring and cover. Secure cover with 6 cap screws.
8. Install pulley with 4 washers and cap screws.

INSTALLATION

1. Install water pump assembly onto engine and install drive belt.

   NOTE: To determine rotation of engine, refer to Section 1, "Engine Rotation Terminology".

   a. Standard Rotation Engine: Position water pump so that standard rotation outlet hose connection is on top (marked on rear cover) and pump inlet hose connection is on bottom.
   b. Opposite Rotation Engine: Position water pump so that opposite rotation outlet hose connection is on top (marked on rear cover) and pump inlet hose connection is on bottom.
2. Install inlet and outlet hoses.
3. Adjust bracket to correct belt tension.

DRAINING INSTRUCTIONS
MERCRUISER 120-140-165
With B-61086A2 CLOSED COOLING SYSTEM

DRAINING FRESH WATER SECTION of COOLING SYSTEM

CAUTION: Reservoir is equipped with a 14 lb. pressure cap. To remove cap, turn ¼-turn to allow pressure in cooling system to escape, then turn cap all-the-way off.

1. If possible, place a container under drains to prevent water from draining into boat.
2. Remove fill cap from reservoir. (Figure 1)
3. Remove hose from front of heat exchanger (Figure 1) to drain fresh water heat exchanger and reservoir.
4. Drain fresh water from cylinder block. Drain hole is located on the right side of block. (Figure 1)
5. When fresh water section has drained thoroughly, apply Perfect Seal No. 4 (C-92-34227) on threads of plugs and reinstall. Tighten securely.
6. Reinstall hose and clamp.

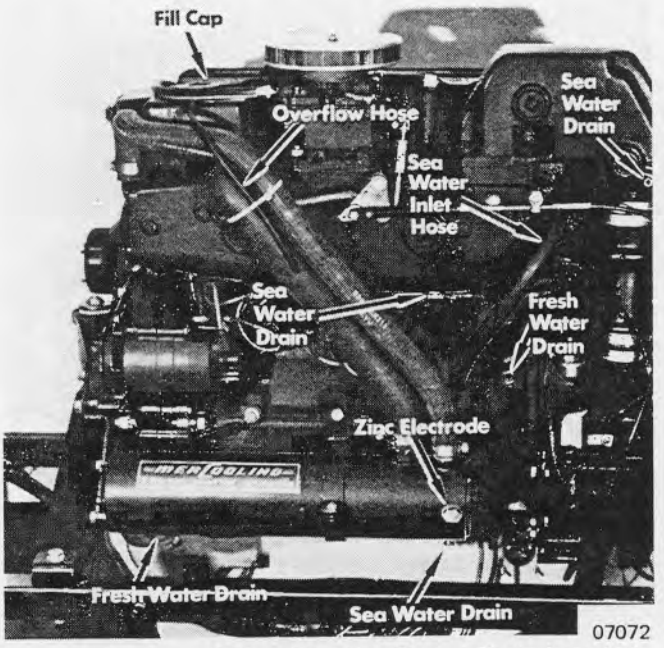


Figure 1. Engine and Closed Cooling System Drain Locations

DRAINING SEA WATER SECTION of COOLING SYSTEM

1. If possible, place container under drains to prevent water from draining into boat.
2. Remove sea water drain plugs from heat exchanger, bottom of exhaust manifold and, on 140 and 165 models, remove drain plug from exhaust manifold elbow. (Figure 1)
3. Remove zinc electrode (Figure 1) from heat exchanger.
4. Remove sea water inlet hose (Figure 1) from heat exchanger.
5. When sea water section has drained thoroughly, apply Perfect Seal No. 4 (C-92-34227) on threads of plugs and reinstall. Tighten securely.
6. Inspect zinc electrode. Replace if eroded.
7. Reinstall hose and clamp.

CLEANING SEA WATER SECTION of EXCHANGER

1. Remove all hoses from heat exchanger.
2. Remove cap screws from rear and front heat exchanger bracket and remove exchanger from engine.
3. Remove screw, which fastens end plate to exchanger, and remove plate.
4. Clean water passages by inserting a suitable size brush through them.
5. Coat both sides of NEW end plate gasket with Perfect Seal (C-92-34227).
6. Replace sealing washer on end plate attaching screw and install end plate onto exchanger. Tighten screw securely.
7. Reinstall heat exchanger to engine.
8. Reinstall all hoses and clamps.

IMPORTANT: DO NOT operate engine without cooling water flowing through sea water pickup pump, as pump will be damaged.

9. Operate engine and check for leaks.

NOTE: Fresh water section of cooling system should be drained and filled with new coolant at least once a year. Refer to draining and filling instructions in this section.

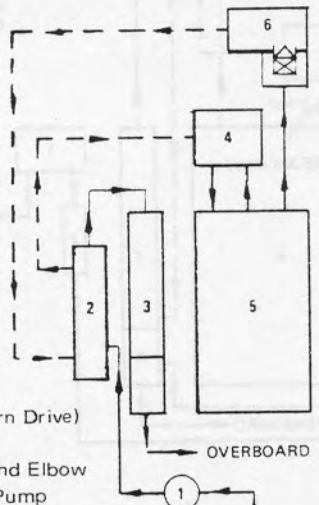
1. It is recommended that coolant level of heat exchanger be checked periodically and coolant added as necessary.
2. If coolant level is excessively low, cooling system should be checked for leaks and repaired as necessary.

CAUTION: Reservoir is equipped with a 14 lb. pressure cap. To remove cap, turn ¼-turn to allow pressure in cooling system to escape, then turn cap all-the-way off.

3. Normal coolant level will fill expansion tank half-way. If expansion tank is over-filled, excess coolant will flow out overflow pipe when engine reaches operating temperature.

CLOSED COOLING SYSTEM - WATER FLOW

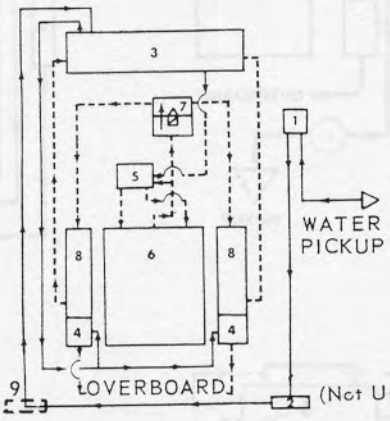
MERCRUISER STERN DRIVE
120-140-160 and 165 (VERTICAL RESERVOIR)



1 - Water Pump (in Stern Drive)
2 - Heat Exchanger
3 - Exhaust Manifold and Elbow
4 - Engine Circulating Pump
5 - Engine Block and Head
6 - Thermostat Housing and Reservoir

(———) Sea Water
(– – – –) Fresh Water

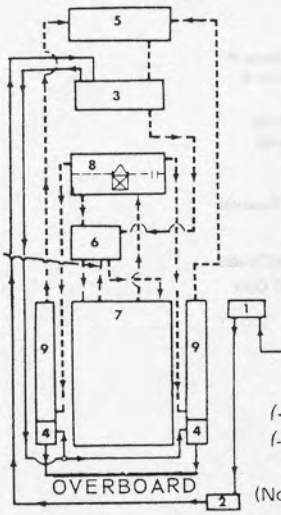
MERCRUISER STERN DRIVE
and INBOARD ENGINE
225-250-270-325 (ROUND RESERVOIR - Old Style)



1 - Sea Water Pump
2 - Transmission Oil Cooler
3 - Heat Exchanger
4 - Exhaust Elbows
5 - Circulating Pump
6 - Cylinder Block and Heads
7 - Thermostat Housing
8 - Exhaust Manifolds
9 - Engine Oil Cooler (325 only)

(———) Sea Water
(– – – –) Fresh Water

MERCRUISER STERN DRIVE
and INBOARD ENGINE
215 and 270 (SQUARE RESERVOIR)



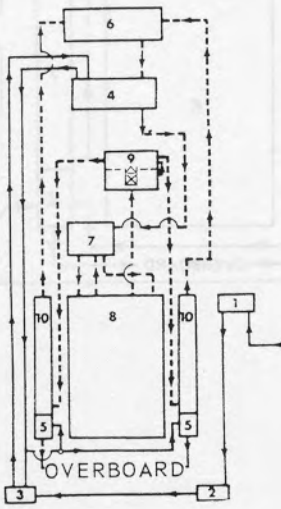
(MCM and MIE 270 Only)

1 - Sea Pump
2 - Transmission Oil Cooler
3 - Heat Exchanger
4 - Exhaust Elbow
5 - Water Reservoir
6 - Circulating Pump
7 - Engine Block and Heads
8 - Thermostat Housing
9 - Exhaust Manifold

(———) Sea Water
(– – – –) Fresh Water

(Not on MCM-215)

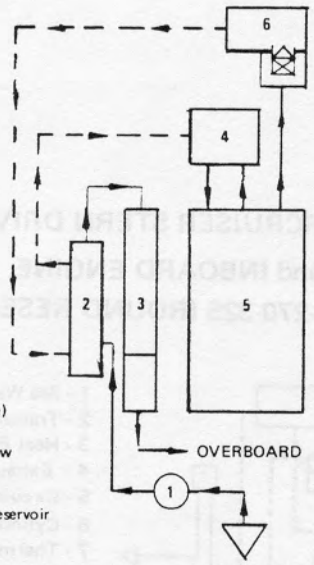
MERCRUISER STERN DRIVE
and INBOARD ENGINE
325 and 390 (SQUARE RESERVOIR)



1 - Sea Pump
2 - Transmission Oil Cooler
3 - Engine Oil Cooler
4 - Heat Exchanger
5 - Exhaust Elbow
6 - Water Reservoir
7 - Circulating Pump
8 - Engine Block and Heads
9 - Thermostat Housing
10 - Exhaust Manifold

(———) Sea Water
(– – – –) Fresh Water

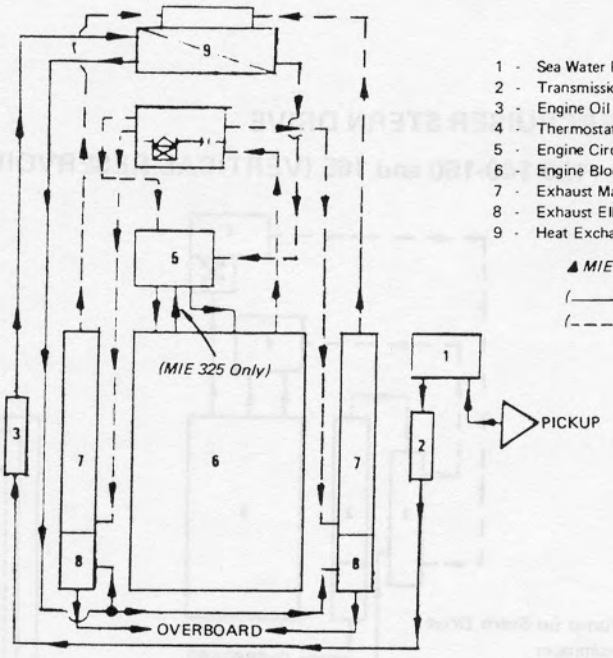
MERCRUISER STERN DRIVE
120/140/165 (HORIZONTAL RESERVOIR)



1 - Water Pump (in Stern Drive)
2 - Heat Exchanger
3 - Exhaust Manifold and Elbow
4 - Engine Circulating Pump
5 - Engine Block and Head
6 - Thermostat Housing and Reservoir

(———) Sea Water
(- - - -) Fresh Water

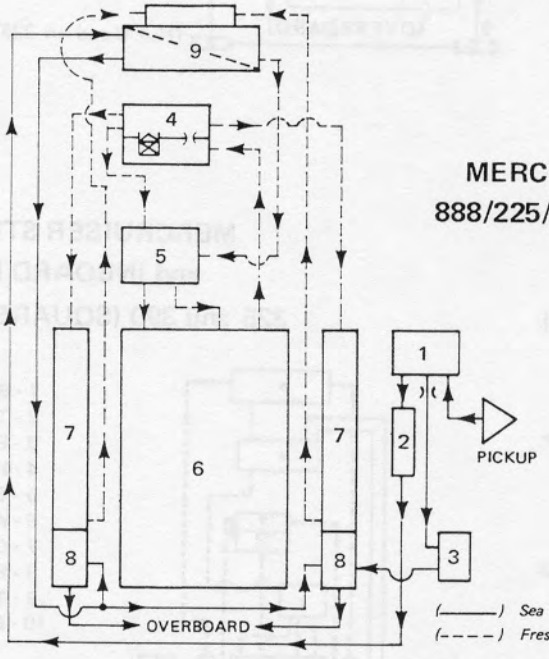
MERCRUISER INBOARD ENGINE
215/255/325 (ROUND RESERVOIR - Late Style)



1 - Sea Water Pump
2 - Transmission Oil Cooler
3 - Engine Oil Cooler ▲
4 - Thermostat Housing
5 - Engine Circulating Pump
6 - Engine Block and Heads
7 - Exhaust Manifold
8 - Exhaust Elbow
9 - Heat Exchanger and Reservoir

▲ MIE 325 Only
(———) Sea Water
(- - - -) Fresh Water

MERCRUISER STERN DRIVE
888/225/255 (ROUND RESERVOIR - Late Style)



1 - Sea Water Pump
2 - Power Steering Oil Cooler ▲
3 - Transmission Oil Cooler ●
4 - Thermostat Housing
5 - Engine Circulating Pump
6 - Engine Block and Heads
7 - Exhaust Manifold
8 - Exhaust Elbow
9 - Heat Exchanger and Reservoir

(———) Sea Water
(- - - -) Fresh Water

▲ Optional on MCM 888
● MCM 225/255 Only

SECTION 7 - ACCESSORIES

MERCRUISER

PART E - GENERAL ACCESSORIES

MERCURY MARINE

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SECTION 7 - ACCESSORIES

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MERCURY MARINE

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MERCATHODE SYSTEM

DESCRIPTION

A properly installed MerCathode System will function trouble-free. To ensure proper corrosion protection, however, it is recommended that the system be checked with a MerCathode Tester (C-91-46802A1).

PRECAUTIONS

METAL BOATS

Any metal boat, which uses the MerCathode System, requires that an anode insulating kit be installed. The insulator disc (5" [12.7cm] diameter) provides a shield to protect the metal hull from over-protection in the area adjacent to the anode.

PAINTING HULLS

Wood or fiberglass boat bottoms, painted with a metal base anti-fouling paint, will accelerate corrosion. Since fresh anti-fouling paint is highly conductive, the MerCathode System capacity could not effectively protect the drive housings.

If a hull must be painted with conductive metal base anti-fouling paints, DO NOT PAINT lower unit or housing, anode and reference electrodes. Leave an insulating median around the clamp brackets or drive housings, which is a non-conductive surface 1" (25.4mm) wide. It will help reduce some of the corrosion effects. A non-conductive bottom paint on any hull is more compatible with aluminum drive housing units and more easily protected by a MerCathode System.

IMPORTANT: Anti-fouling paints of a tri-n-butyltin resinate base can be safely applied to stern drive units and boat bottoms to deter sea growth. Follow the paint manufacturer's recommendations for application. Anti-fouling paints, which contain copper or mercury compounds, should not be used, as they will increase corrosion; however, they can be applied on wood or fiberglass hulls, only if a MerCathode System is installed and if an unpainted border between the hull and stern drive unit is provided, as described in the "MerCathode Installation Instructions". Normally painted metal surfaces of the stern drive unit and boat bottom, that have become exposed, must be repaired for added protection against corrosion. Repaint exposed stern drive metal with Quicksilver Zinc Chromate Primer (C-92-31292) and Phantom Black Paint (C-92-32291) before applying a recommended anti-fouling paint. For repainting the boat bottom, follow its manufacturer's recommendations.

LARGE METAL BOATS

Large aluminum or steel metal boats require a cathodic protection system capable of protecting the boat hull.

The MerCathode System is not designed to protect such large metal surfaces. A MerCathode System, however, must be installed in addition to the cathodic system for steel boats, since aluminum requires slightly more potential for protection than does steel.

ELECTRICAL SHORE POWER CONNECTIONS

Shore power plug-in connections should be polarized to prevent reversing ground polarity. Reversed ground polarity causes rapid metal deterioration by electrolysis within a very short period of time.

Quicksilver Isolator (C-59729A1) in the boat's electrical system will assure proper system ground, regardless of fluctuations in shore power grounding. Marine systems, as a rule, have negatively grounded systems.

WIRING FOR DOCK-SIDE POWER

Wiring for dock-side power (cratt equipped with stern drive) should be accomplished by a marine electrician.

NOTE: Quicksilver Isolator (C-59729A1) can be installed in dockside 3 or 4 wire power supply of 120/240 volts AC to protect metal hulls and stern drive unit from accelerated corrosion and provide protection against AC or DC shock hazards. The Quicksilver Isolator will block passage of destructive low voltage galvanic currents while providing a ground path for shock current.

CAUTION: Dockside A-C shore based power ground must be isolated from drive power package grounds. Improper grounding will cause rapid metal deterioration thru accelerated corrosion which is beyond the capacity of MerCathode System to prevent.

TROUBLESHOOTING

Continued metal erosion after installation of MerCathode indicates that hull potential is now-- or was at some time in the past -- below 0.8 volts. This low hull potential may be caused by the following:

1. MerCathode not installed or not operating properly. Refer to "MerCathode Installation Checks", following.
2. Stray current (sometimes referred to as "electrolysis") which is caused by an improperly wired device or pow-

er source. Refer to "Stray Corrosion Current Checks", following.
3. Excessive exposed metal, such as an aluminum hull or a non-metal hull painted with a conducting paint. See following paragraph, "Excessive Exposed Metal".

MERCATHODE INSTALLATION CHECKS

1. Splash-proof connections are secured according to installation instruction wiring diagram.
2. Protector leads are direct to battery and fuses or switches are not in the system.
3. Spliced connections are soldered and waterproofed.
4. Protector control is mounted away from engine or manifold heat and bilge water.
5. Electrodes are mounted thru transom below water line, not painted and have not been cleaned with abrasives.
6. Battery(s), drive assembly(s) and engine(s) are to a common ground.
7. Battery(s) is fully charged, not disconnected or removed and hooked up properly to engine(s) and boat(s) electrical system.
8. Had any of these (in Paragraph 7 immediately preceding) occurred before? If so, it is possible that the corrosion occurred at that time.

STRAY CORROSION CURRENTS CHECKS

If Hull Potential Meter Reads Below 0.8 Volts after Installation and Check of MerCathode . . .

1. Disconnect all shore connections except plastic rope. This includes AC shore power, water lines, salt water soaked lines, etc.
2. Disconnect all battery terminals with exception of MerCathode protector(s).
3. Repeat hull potential check. If potential increases, the problem was stray current.
4. Reconnect each wire to the system one-at-a-time, observing hull potential until offending connection is located.
5. If hull potential is still below 0.8 volts on tester, excessive exposed metal areas exist.

EXCESSIVE EXPOSED METAL

If Potential Meter Reads below 0.8 Volts with All Shore and Boat Power Disconnected . . .

1. Paint exposed metal surfaces to bring boat hull potential within capacity of the MerCathode System.
2. Metallic base, anti-fouling paints are <u>not</u> to be used on boat hulls which are contrsucted of aluminum or steel. It will greatly accelerate corrosion between hull and paint. Non-metallic vinyl base paints are best suited for metal hulls.
3. If a hull must be painted with conductive metal base anti-fouling paints, DO NOT PAINT lower unit or housing, anode and reference electrodes. Leave an insulating median around clamp brackets or drive housing, which is a non-conductive surface 1" (25.4mm) wide. It will help reduce some of the corrosion effects. A non-conductive bottom paint on any hull is more compatible with aluminum drive housing units and more easily protected by a MerCathode System.

NOTE: Refer to "Important" paragraph on Page 7E-1.

DETERMINING WATER ELECTRICAL CONDUCTIVITY

1. The graph (Figure 1) is based on a battery voltage of 12.6 volts. If a dry battery or wet battery is used, be certain that it is fully charged and delivering the specified voltage. Do not use battery in a boat while engine is running or while battery is being charged.
2. Connect negative (-) side of battery to an old propeller or housing, then place in water.
3. Connect a 50-ohm resistor, with a power rating of at least 2 watts, to positive (+) side of battery. (Figure 2) If this test is performed with no series resistor, the protective fuse within the MerCathode Tester may be blown, due to excessive current.

NOTE: Purchase resistor locally or order Part No. C-47892 from Mercury franchised dealer.

4. Connect MerCathode Tester "Battery+" lead to resistor.
5. Connect MerCathode Tester "Protector+" lead to a MerCathode anode.
6. Place switch on MerCathode Tester in direction of black arrow.
7. Lower anode into water 2 feet from submerged aluminum metal.

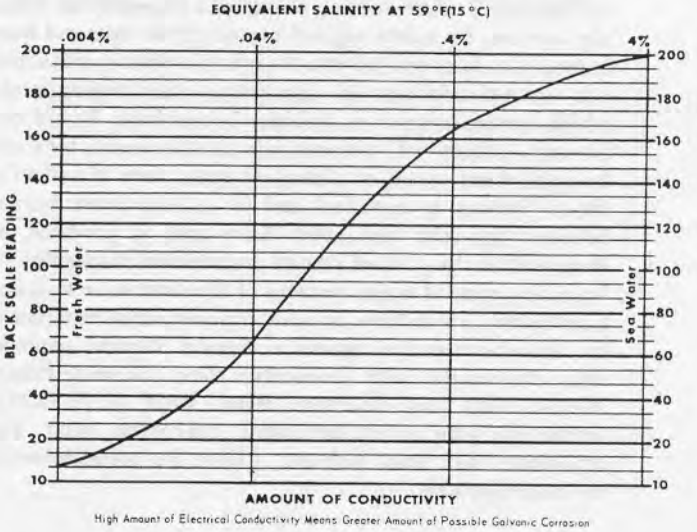

Figure 1. Electrical Conductivity Graph

CAUTION: Do not hang anode in water while held only by clip.

8. Read anode current in milliamperes on black scale of MerCathode Tester.
9. Refer to graph (Figure 1) to determine amount of electrical conductivity. The higher the meter reading, the greater amount of possible galvanic corrosion.

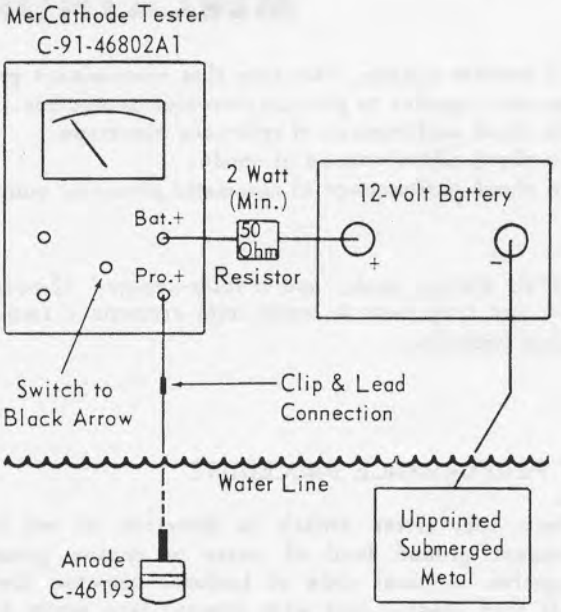

Figure 2. Tester Schematic Wiring Diagram

MERCATHODE TESTER (C-91-46802A1) DESCRIPTION

The MerCathode Tester is a specially constructed test instrument used to monitor operation of the MerCathode Anti-Corrosion System and to check operation of components in order to locate any malfunction that may exist. Test Meter C-91-46802 is a combination DC voltmeter and milliameter. Test the MerCathode system periodically to assure proper protection. The MerCathode System consists of 3 components which are factory-sealed and cannot be repaired, thus, should be replaced individually. (Fig. 3)

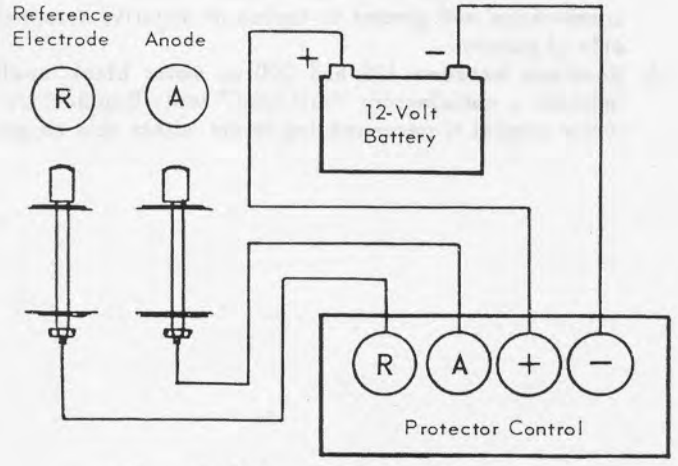

Figure 3. Schematic Wiring Diagram

1. Automatic protector control which is mounted inside boat.
2. "Anode" electrode (identified by letter "A"), mounted thru transom below water line, delivers protective current.
3. "Reference" electrode (identified by letter "R"), mounted thru transom below water line, governs protector control so that it continuously provides proper protective current via the anode.

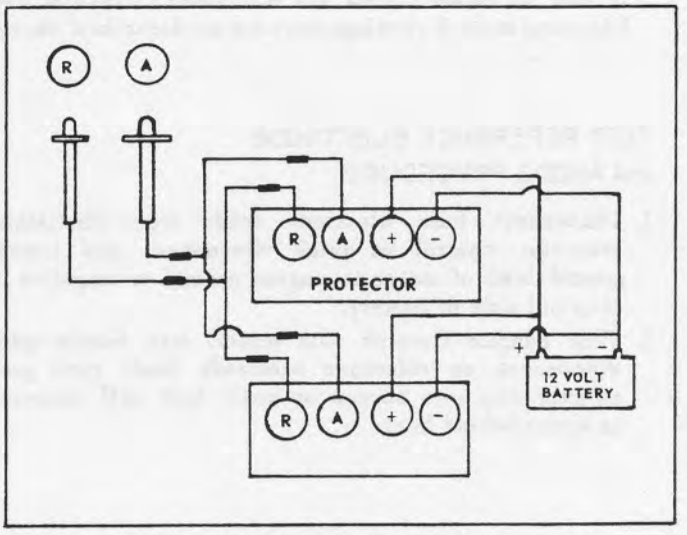

Figure 4. Schematic Wiring Diagram with Additional Protector

Protection against corrosion has been achieved when reference potential reads between 0.8 and 1.05 on the red scale. If stern drive or outboard is equipped with new clean zinc anodes, a satisfactory reference potential may be observed on test meter without installation of the MerCathode System. However, zinc anodes are sacrificial, and continued protection can be achieved only by installation of the MerCathode System. Zinc anodes will provide interim protection, should battery be removed from boat or discharged.

Various craft may require more than one MerCathode System. The need for additional MerCathode Systems or protector may be determined by testing. (Figure 4) See "Troubleshooting", preceding.

DO NOT paint "anode" or "reference" electrodes.

MERCATHODE TESTER FUNCTIONS

1. To monitor system, checking that components properly operate together to provide corrosion protection.
2. To check performance of reference electrode.
3. To check effectiveness of anode.
4. To check performance of automatic protector control.

NOTE: During tests, use a fully-charged 12-volt battery and keep boat in water with electrodes immersed below waterline.

TEST PERFORMANCE PROCEDURE

1. Place test meter switch in direction of red arrow. Connect ground lead of meter to engine ground or negative terminal side of battery. Immerse the half cell (red plastic unit with screen) into water behind boat transom.
2. Read between 0.8 and 1.05 on meter red scale, then disconnect reference electrode lead from protector control at quick disconnect and wait one minute. If meter reading increases, system is operating properly and no further tests are necessary. Proceed with following tests if readings were not as described above.

TEST REFERENCE ELECTRODE and ANODE PROCEDURE

1. Disconnect both electrode leads from MerCathode protector control at quick disconnect and connect ground lead of meter to engine ground or negative (-) terminal side of battery.
2. Plug adaptor (furnish with tester) into female quick disconnect on reference electrode lead, then press adaptor clip into screen on meter half cell, immersed in water behind boat.
3. Readings between .5 and 1.05 on meter red scale indicate proper reference electrode operation. If meter reading is not within this range, replace "reference electrode". Check "anode" in Step 4, following.
4. Remove reference electrode lead from adaptor and connect "anode" lead at quick disconnect into adaptor, then press clip into screen on half cell.
5. Readings between .8 and 2.0 on meter red scale indicate proper "anode" operation; that it is not shorted and that platinum surface is intact. If meter reading is not within this range, replace "anode".

TEST PROTECTOR CONTROL PROCEDURE

1. Place test meter switch in direction of black arrow. Disconnect "reference electrode" and "anode" leads from protector at quick disconnect, if not already disconnected.
2. Disconnect (red band) lead of protector control from battery positive terminal side and connect it to tester lead which is marked "protector". Connect tester lead (marked "battery") to positive terminal side of battery.

NOTE: DO NOT ground meter "battery" lead. If this accidentally happens, remove meter case and replace 3AG or AGC fuse (½ amp). A spare fuse is located in a clip above fuse used in meter circuit.

3. Readings between 3 and 15 on meter black scale indicate a satisfactory "no load" test. Replace protector control if meter reading is not within this range. Perform "full load" test, following, if reading is within range.
4. Connect adaptor (furnished with tester) to protector's "reference electrode" and "anode" lead quick disconnections and ground to engine or negative terminal side of battery.
5. Readings between 120 and 200 on meter black scale indicate a satisfactory "full load" test. Replace protector control if meter reading is not within this range.

MERCRUISER RADIO NOISE SUPPRESSION

DESCRIPTION

MerCruiser radio noise suppression kits are made of the finest equipment available for reduction of radio and electronic interference caused by ignition and alternator systems. When installed according to instructions, it will greatly reduce ignition and alternator interference. If radio interference is still experienced, the trouble chart (following) may be of help in locating it.

PRECAUTIONS

The following precautions, regarding installation of radio receivers and other electronic equipment, may be helpful:

1. Install antenna as far as practicable from engine and remote control cables. Also, select an antenna suitable for the frequency on which it is intended to operate.
2. Antenna should be shielded and shield should be grounded.
3. All grounds should terminate at one point in order to avoid forming a ground loop circuit.
4. Condition of breaker points plays an important role in preventing marginal ignition performance, as a completely suppressed ignition system would be less tolerable of breaker point neglect. Breaker points, that are well maintained, help decrease any possible noise signals and also provide the utmost in engine performance.
5. Receiver-transmitter voltage must be taken directly from the battery. Tapping into accessory ignition switch will result in feedback and intercoupling, thus causing interference between electrical system and radio circuit.
6. Alternator brushes ride directly on slip rings. If noises, similar to direct current generator "whine", are experienced, check brush contact and clean slip rings.

SERVICING RADIO NOISE SUPPRESSION KITS

Under no circumstance should shielded cables be pierced, as this will short cables to ground and damage them. To make connections to spark plugs for timing or scope readings, use adaptor lead C-91-39212.

Spark plug cables are not to be repaired and require replacement if defective or damaged. Remove and replace cables as follows:

1. Lift snap nut off cap with screwdriver and pull cable from distributor cap.
2. To insert new cable, lubricate with DC4 Compound (C-92-24108) and fold insulator as shown in Figure 1. Press insulator and cable into distributor cap and press snap nut onto cap.

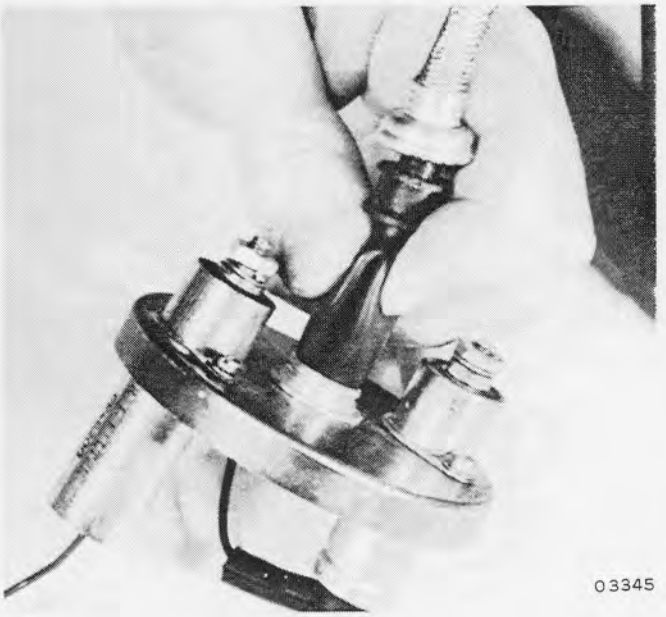

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Figure 1. Folding Insulator

INSTRUMENT INTERFERENCE CHECK

1. Turn radio on full volume.
2. Turn ignition switch "on" and jar all instrument gauges.
3. Disconnect the "hot" wire of all instrument gauges except the one being checked. Temperature gauge is the most frequent offender making a "hissing or crackling" sound. A low pitched clicking noise is emitted by the oil sender.
4. In most cases, placing a .25 - .50 mfd bypass capacitor to ground will eliminate noise.
5. Touching a grounded capacitor to all electrical connections and on all unsuppressed small motors at hot input wires or brush holders often may locate more offenders. Install a by-pass capacitor on any offender isolated by this check.

TROUBLE CHART

Source of Noise	Type of Noise
Ignition system	A "popping" noise that will increase with engine RPM. Noise will stop instantly when key is turned off.
Alternator	High pitched "whine". Check brush contact and clean slip rings.
Regulator	A "rasping" noise that will continue for a short time after key is turned off at a fast idle.
Instruments	A "hissing and crackling" noise that is heard when instruments are jarred with ignition "on".

QUICKSILVER PROPELLERS
REMOVAL and INSTALLATION

1. Refer to Figures 1-2-3-4-5 and selection charts, following.
2. Bend back tabs which retain propeller nut, except MerCruiser 60.
3. Place block of wood between anti-cavitation plate and propeller edge.
4. Remove nut, then tab washer (splined washer, thrust washer), propeller, thrust hub (and washer, MerCruiser 80-thru-160).
5. Lubricate propeller shaft splines with Quicksilver Anti-Corrosion Grease (C-92-45134) and reinstall propeller by reversing disassembly steps.

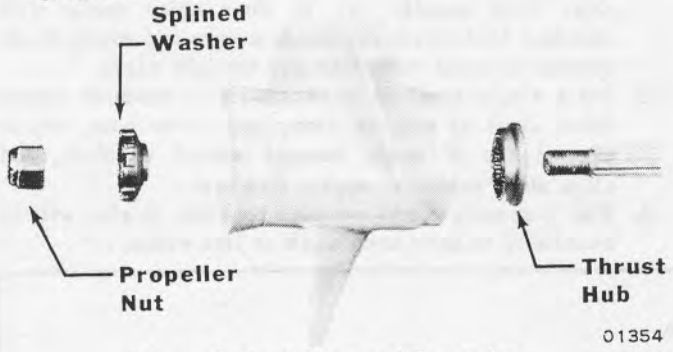


Figure 1. Installing and Removing MerCruiser 60 Propeller

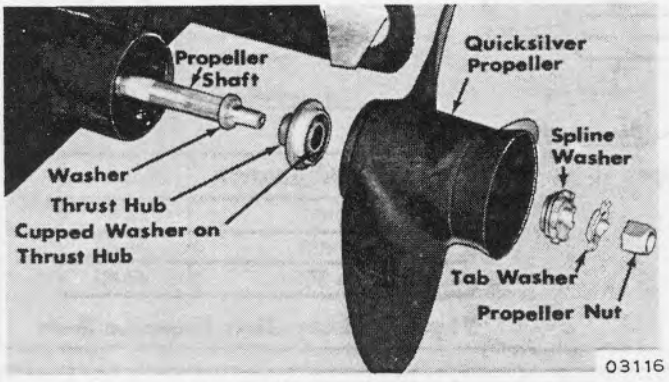


Figure 2. Installing and Removing MerCruiser 80-thru-165 Propellers

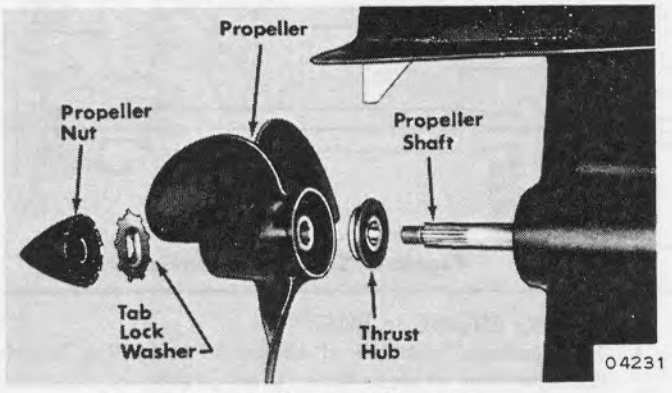


Figure 3. Installing and Removing MerCruiser II-200-225 Propellers

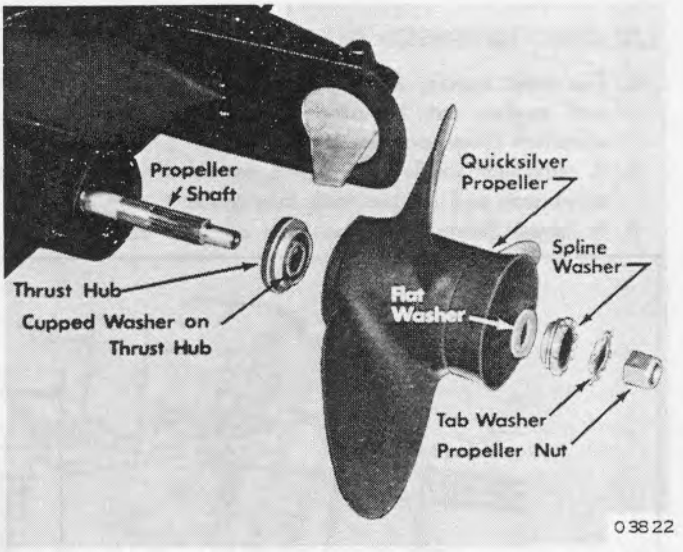


Figure 4. Installing and Removing MerCruiser 250-thru-390 Propellers

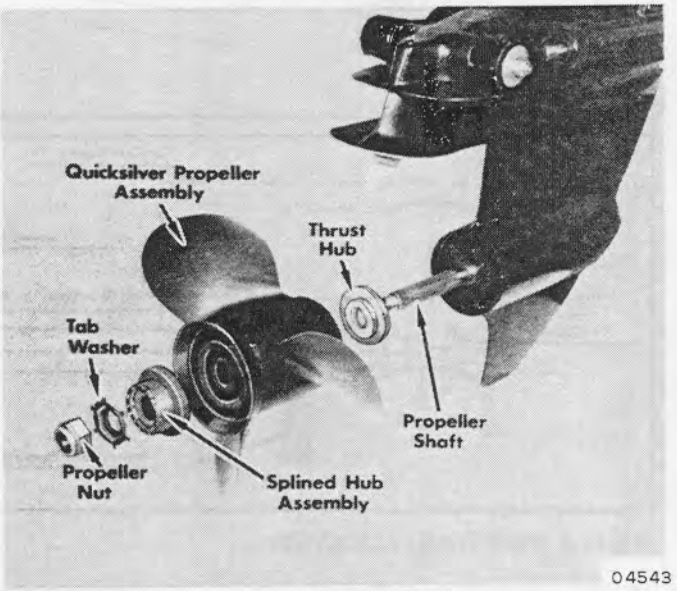


Figure 5. Installing and Removing MerCruiser 215-E-H Propellers

NOTE: Refer to "Specifications" Section 8 for propeller recommendations.

HEAVY DUTY EXTENSION SHAFTS - MERCRUISER II INSTALLATION

SHAFT LENGTHS

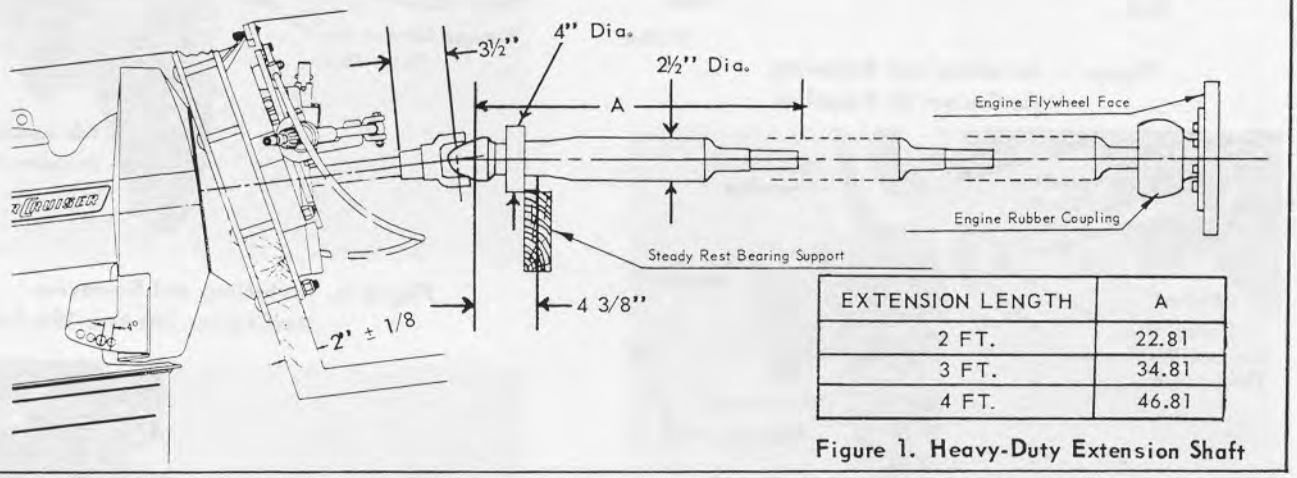
1. MerCruiser heavy duty extension shafts with steady rest bearing are available to permit engine installations forward of standard position if desired.
2. Shaft B-32458 is available in 2 ft., 3 ft. and 4 ft. lengths with intermediate lengths available on special order. (Figure 1)

LOCATING EXTENSION SHAFT

1. For most boats, a single shaft is usually adequate, and engine can be placed up to 4 ft. forward from standard close-coupled position.
2. A maximum angle of 8° can be taken between stern drive unit and engine with this shaft.
3. In larger boats, combinations of 2 or more shafts, of lengths needed, can be coupled together to place engine farther forward. (Figure 2)

ALIGNING EXTENSION SHAFT

1. To maintain a smooth running extension shaft and efficient power transmission, it is important to correctly align extension shaft to engine and to stern drive unit. This usually can be done quite easily with standard MerCruiser alignment gauges and easily-made wooden or metal templates and straight edges.
2. For a single shaft, it is necessary to correctly center drive shaft of unit in clamp nut cover bore, not to exceed the 8° angle through swivel of shaft, and align shaft square to engine flywheel.
3. With 2 or more shafts coupled together, it also will be necessary to have each shaft in line within ± 1°.



EXTENSION LENGTH	A
2 FT.	22.81
3 FT.	34.81
4 FT.	46.81

Figure 1. Heavy-Duty Extension Shaft

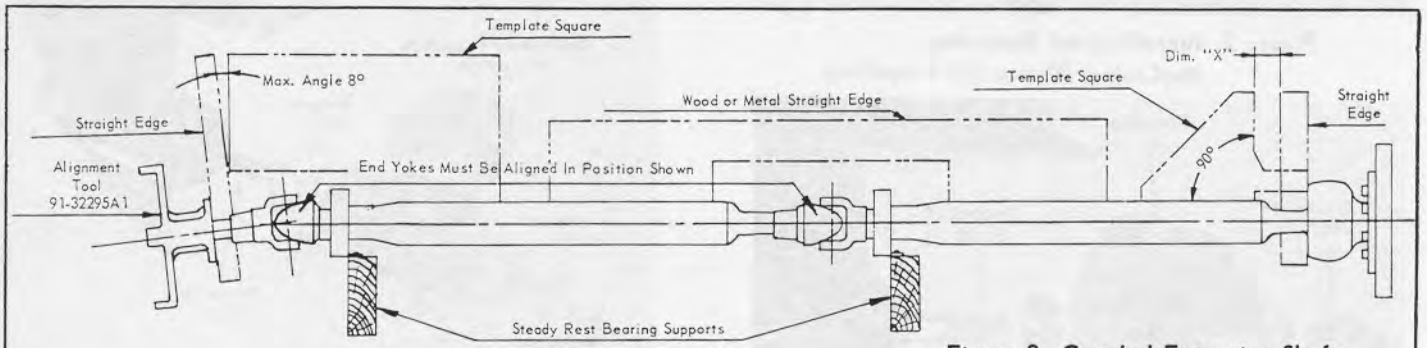


Figure 2. Coupled Extension Shafts

SINGLE SHAFT INSTALLATION

1. To make an installation using a single shaft first install transom plates to the boat.
2. Insert drive unit and lock it up in running position.
3. Clamp Aligning Tool (C-91-32295A1) onto drive shaft of unit tightly against face of clamp nut.
4. Insert thin metal shims of equal thickness between arms of aligning tool and bore of clamp nut cover, as this will locate and hold drive shaft of unit in place.

LOCATING ENGINE in BOAT

1. To determine location of engine in boat, first couple the extension shaft to drive shaft of unit.
2. Couple other end of shaft to rubber coupling on flywheel of engine and arrange location of engine to suit length of shaft and desired angle.
3. Install wooden supporting members for motor.
4. With engine, shaft and drive unit coupled together, set motor loosely on its mounting. Engine now should be aligned so that flywheel is square to extension shaft.

ALIGNING ENGINE and SHAFT

1. Place template square against outside diameter of shaft and face of rubber coupling. (Figure 2)
2. Using a straight edge across face of coupling, measure dimension "X" in a horizontal position on each side of shaft (180° apart). Dimension "X" should be equal in each position within ±1/8.
3. Move forward end of engine to either side to correct dimension "X". This will align engine and shaft in horizontal position.
4. Fasten rear mounting of engine to wooden cross members in boat.
5. Next measure dimension "X" in a vertical position. Raise or lower forward end of engine until this measurement equals that obtained in a horizontal position within ±1/8. Engine now is properly aligned to shaft.

SECURING ENGINE

1. Fasten front engine mounts to wooden cross members of boat.
2. Install wooden cross member in boat for the steady rest bearing and fasten bearing to this cross member.
3. Remove Alignment Tool from drive shaft of unit.

DUAL SHAFT ALIGNMENT

1. When coupling 2 or more shafts together, alignment between shafts can be accomplished with a simple wood or metal straight edge cut out at the center to clear swivel joint and steady rest bearing.
2. Straight sections should be at least 18" long and any opening between shaft outside diameter and straight edge should not exceed 1/16". This also must be done in horizontal and vertical positions.

CAUTION: When coupling 2 or more shafts together, end yokes must be aligned in position shown in Figure 2.

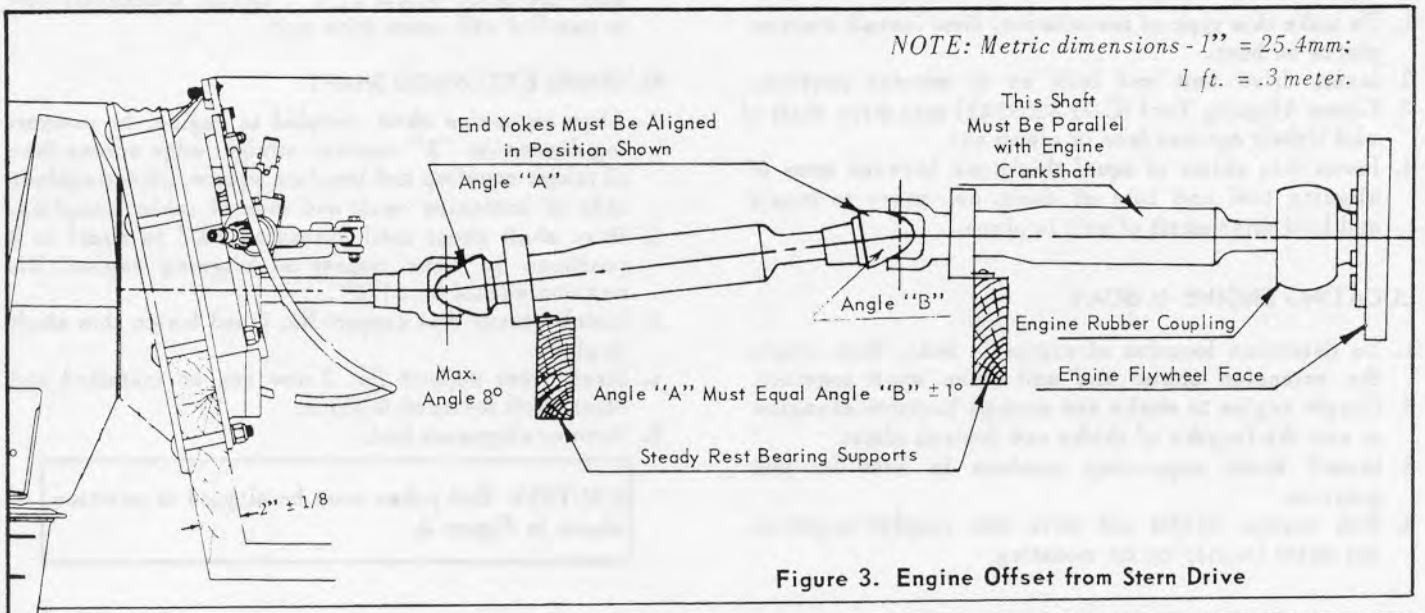


Figure 3. Engine Offset from Stern Drive

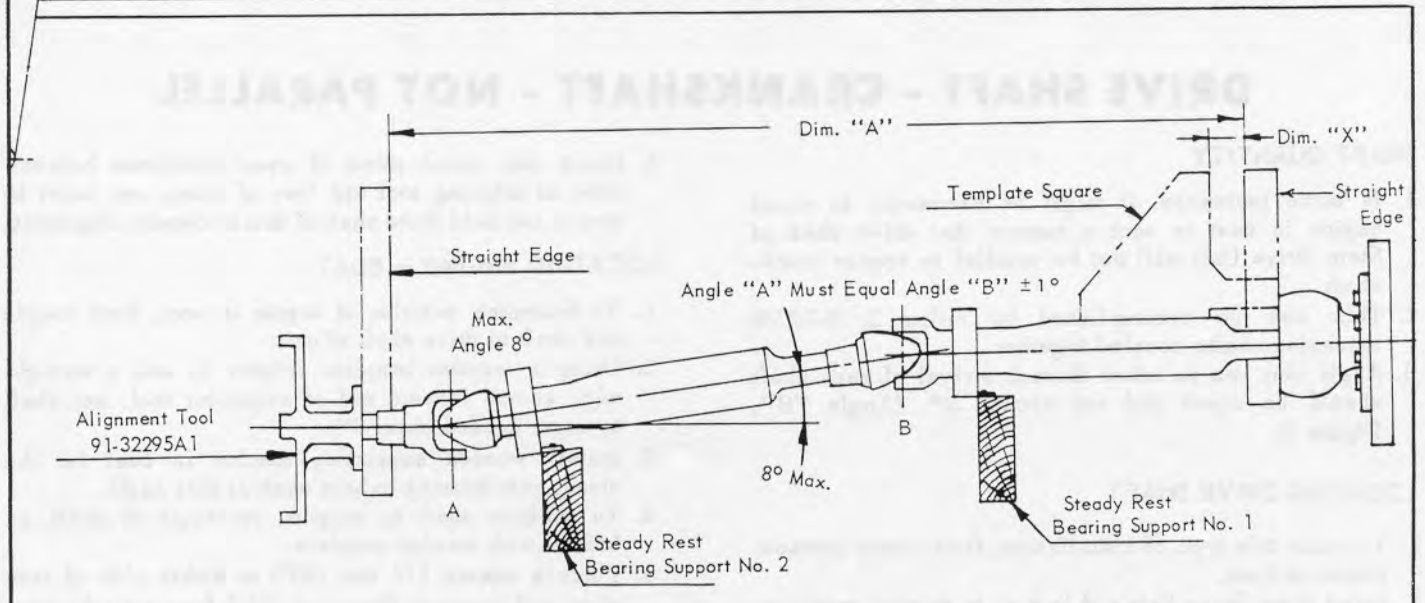


Figure 4. Aligning Crankshaft Parallel to Stern Drive

OFFSET EXTENSION SHAFTS INSTALLATION PARALLEL DRIVE SHAFT - CRANKSHAFT

SHAFT QUANTITY

1. MerCruiser shaft B-32458 also can be used to offset the engine from the stern drive unit. (Figure 3)
2. At least 2 shafts are necessary to accomplish this offset, and the engine will have to be at a minimum of 4 ft. forward from the normal direct drive position.
3. A maximum angle of 8° can be taken through the swivel of each shaft and the offset can be in any direction.
4. Engine crankshaft remains parallel to drive shaft of stern drive unit.

LOCATING DRIVE SHAFT

1. To make this type of installation, first install transom plates on boat.
2. Insert drive unit and lock up in running position.
3. Clamp Aligning Tool (C-91-32295A1) onto drive shaft of unit tightly against face of clamp nut.
4. Insert thin shims of equal thickness between arms of aligning tool and bore of clamp nut cover to locate and hold drive shaft of unit in place.

LOCATING ENGINE in BOAT

1. To determine location of engine in boat, first couple the extension shafts and unit drive shaft together.
2. Couple engine to shafts and arrange location of engine to suit the lengths of shafts and desired offset.
3. Install motor supporting members in boat for this position.
4. With engine, shafts and drive unit coupled together, set motor loosely on its mounting.
5. Engine now should be aligned so that crankshaft is parallel to stern drive unit by placing straight edges across face of forward end of aligning tool and engine rubber coupling. (Figure 4)
6. Measure dimension "A" horizontally in 2 positions 1/2 turn (180°) apart. This dimension should be equal in both positions within ±1/8.
7. If necessary, move forward end of engine to either side until measurements are equal.
8. Tighten rear engine mounting bolts.
9. Measure dimension "A" in a vertical position. This length should be the same as that measured horizontally.
10. If necessary, raise or lower forward end of engine until the same within ±1/8". Engine crankshaft now is parallel with stern drive unit.

ALIGNING EXTENSION SHAFT

1. Align extension shaft, coupled to engine, by measuring dimension "X" between straight edge across face of rubber coupling and template square, placed against side of extension shaft and face of rubber coupling.
2. Move shaft about until dimension "X" is equal in 3 positions in same manner as aligning engine. Dimension should be ±1/8".
3. Install steady rest support No. 1 and fasten this shaft in place.
4. Steady rest support No. 2 now can be installed and other shaft fastened in place.
5. Remove alignment tool.

CAUTION: End yokes must be aligned in position shown in Figure 3.

DRIVE SHAFT - CRANKSHAFT - NOT PARALLEL

SHAFT QUANTITY

1. In some instances, it might be necessary to mount engine in boat in such a manner that drive shaft of Stern Drive Unit will not be parallel to engine crankshaft.
2. This can be accomplished by using 2 B-32758 extension shafts coupled together.
3. Angle that can be taken through swivel of each shaft should be equal and not exceed 8°. (Angle "B", Figure 5).

LOCATING DRIVE SHAFT

1. To make this type of installation, first mount transom plates on boat.
2. Insert Stern Drive Unit and lock up in running position.
3. Clamp Aligning Tool (C-91-32295A1) onto drive shaft of unit tightly against face of clamp nut.
4. Insert thin metal shims of equal thickness between arms of aligning tool and bore of clamp nut cover to locate and hold drive shaft of unit in correct alignment.

LOCATING ENGINE in BOAT

1. To determine position of engine in boat, first couple one shaft to drive shaft of unit.
2. Using a wooden template (Figure 6) and a straight edge across forward end of alignment tool, set shaft to angle needed (max. 8°).
3. Install wooden supporting member in boat for the steady rest bearing to hold shaft at this angle.
4. To position shaft on support, set angle of shaft, as before, with wooden template.
5. Place a square 1/4 turn (90°) to either side of template and measure dimension "A" from straight edge to square. Dimension should be equal in both positions within ±1/8".

6. Bolt steady rest bearing to wooden support.
7. Couple second shaft to first shaft in manner shown in Figure 5.

CAUTION: End yokes must be in the position shown.

8. To align this shaft, be sure that first shaft is held in position after alignment.
9. Set angle of shaft with wooden template. Wooden straight edge places 1/4 turn (90°) to either side against outside of each shaft and line up the 2 shafts in this position. Straight edge should be within 1/8" of touching each shaft in a length of 2 ft. along straight edge.
10. If angle of shafts is too great to measure with straight edge, sight along shafts and straight edge until they appear in line. This is usually adequate because of length of shaft.
11. While holding shaft in this position, install wooden cross member in boat for steady rest bearing.
12. Bolt shaft to support.

ALIGNING SHAFTS

1. Measure from forward end of second shaft to determine position of engine and install engine mounting in boat.
2. Couple engine to extension shafts and set motor loosely on its mounting.
3. Engine crankshaft and shaft entering rubber coupling must be in line. To align engine to shaft which enters rubber coupling shaft, place a straight edge across the face of the rubber coupling and the template square against outside diameter of shaft and touching the face of the rubber coupling.
4. Measure dimension "X" between straight edge and template square in a horizontal position 1/2 turn (180°) apart.
5. Move forward end of engine from side-to-side until dimension "X" is equal in both positions within ±1/8".
6. Bolt rear end of engine to its mounting.
7. Measure dimension "X" in a vertical position.
8. Move forward end of engine up or down until dimension measured in this position is same as that measured horizontally within ±1/8".
9. Bolt front end of engine to its mounting.
10. Remove alignment tool from drive shaft of unit.

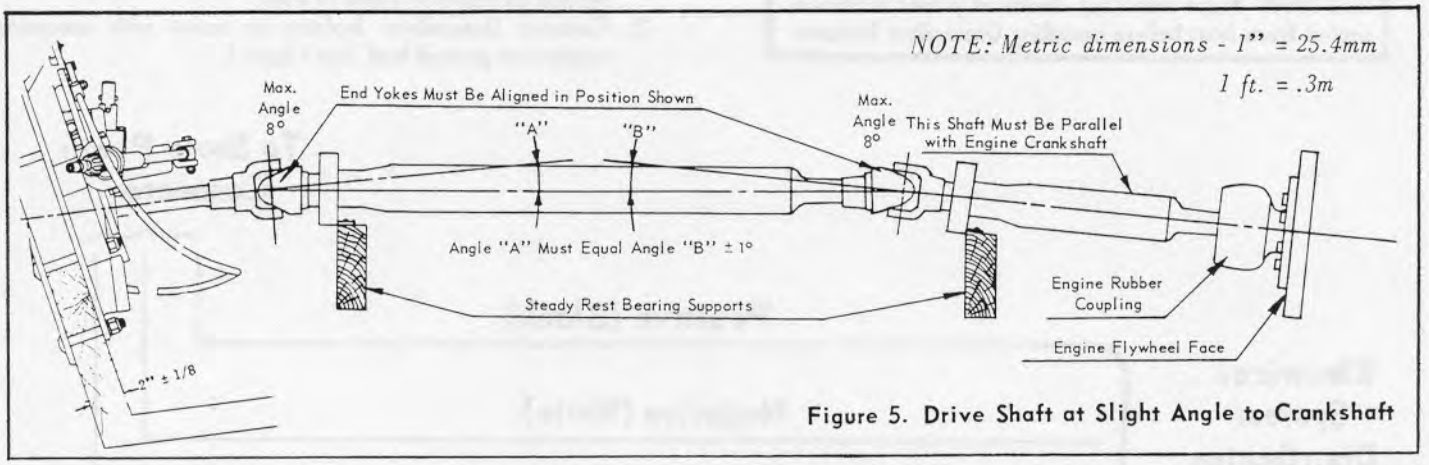


Figure 5. Drive Shaft at Slight Angle to Crankshaft

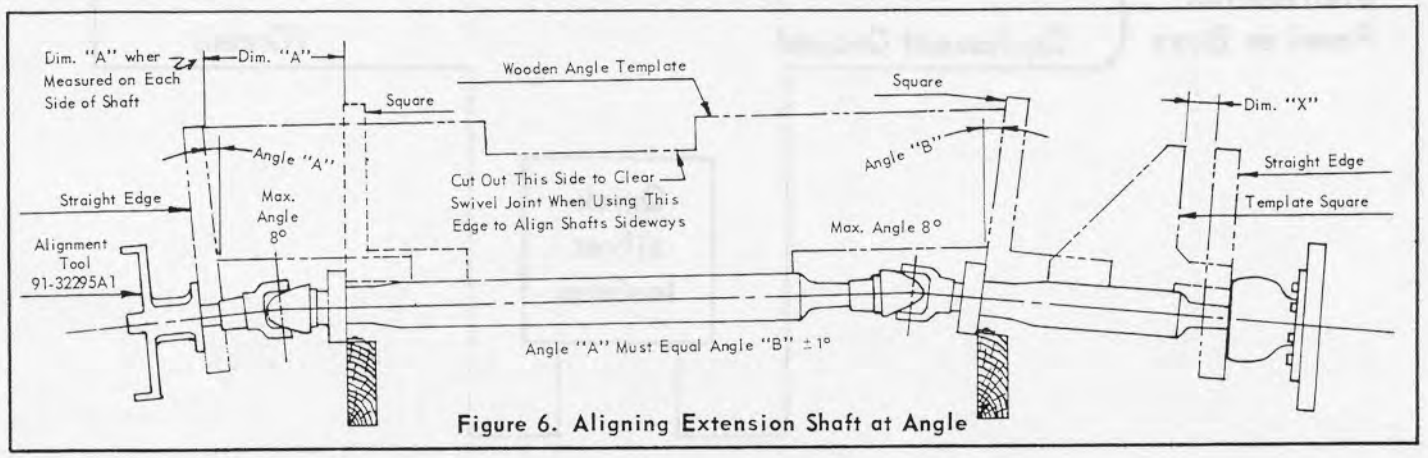


Figure 6. Aligning Extension Shaft at Angle

QUICKSILVER ISOLATOR

DESCRIPTION

The Quicksilver Isolator will protect all underwater metal portions of steel or aluminum hulls and stern drives from accelerated corrosion damage that can occur when the boat is plugged into shore power. It will safeguard persons on board from serious shock hazard, and it will protect against shock hazard which results from stray currents via outside sources.

A properly installed isolator will function trouble-free, and a simple test with a VOA Meter (C-91-52751) will check its proper operation.

NOTE: Replace the isolator if ohm readings are not within the range specified in the test procedure following.

TEST PROCEDURE

1. Set VOA Meter on Rx1 resistance scale.
2. Connect red test lead to one isolator lead. Connect black test lead to other isolator lead. Meter will swing full scale (0 ohms) and return to 27 ohms (plus-or-minus 4 ohms).
3. Reverse test leads. Meter again will swing full scale (0 ohms) and return to 27 ohms (plus-or-minus 4 ohms).
4. Connect red test lead to either isolator lead. Ground black test lead to isolator case. Meter will read infinite resistance.

INSTALLATION

CAUTION: Make sure that electrical power is disconnected from boat before installing Quicksilver Isolator.

1. Mount Quicksilver Isolator to boat close to electrical system distribution panel or buss.
2. Connect Quicksilver Isolator in series with incoming equipment ground lead. See Figure 1.

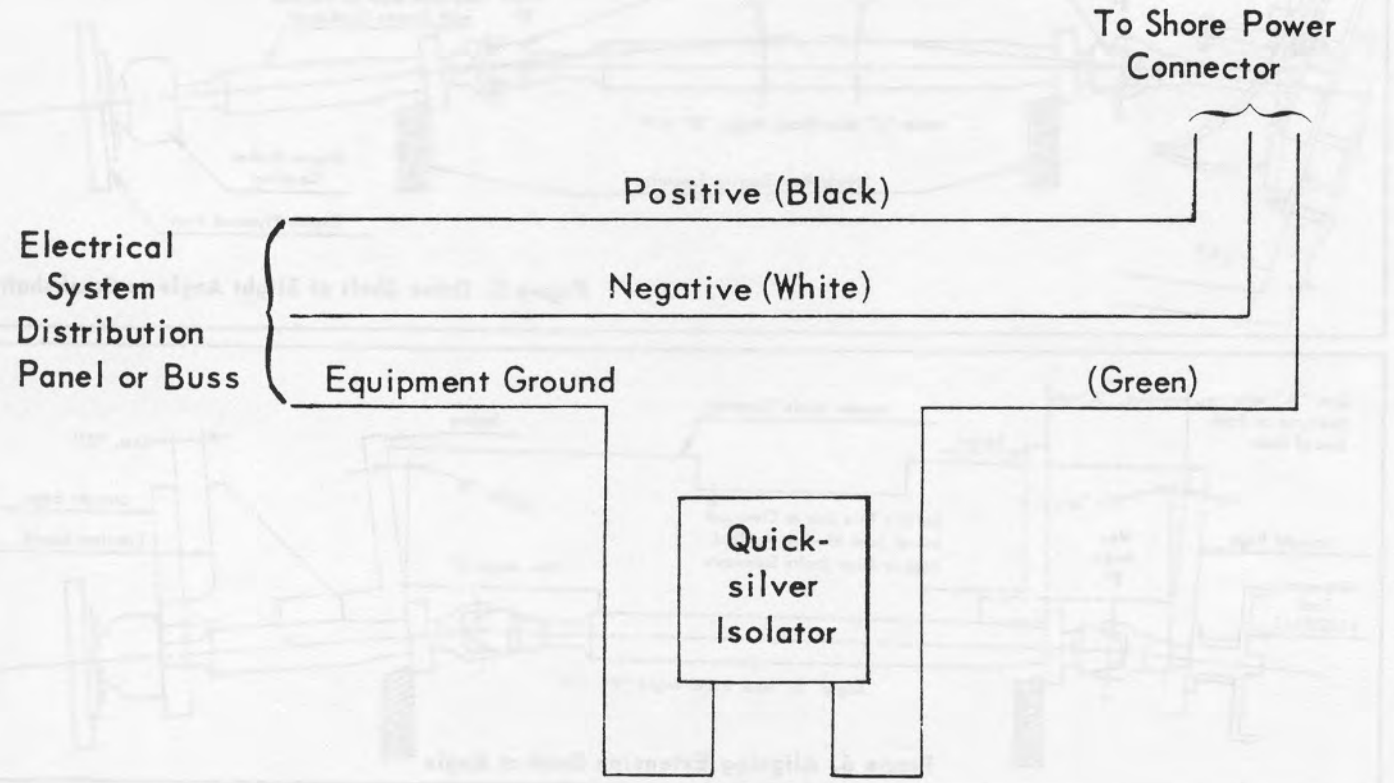
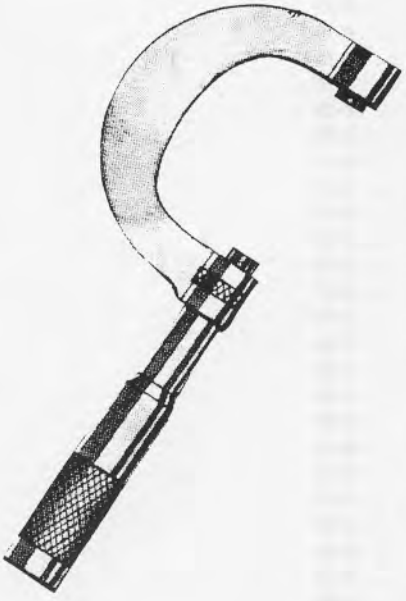


Figure 1. Wiring Diagram

MERCRUISER
SECTION 8



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SECTION 8 - SPECIFICATIONS

MERCRUISER

ENGINE - TORQUE - TUNE-UP

and COMPONENT

MERCURY MARINE

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Model	60	80	90	110-120	140	140	150	160 - 165	200
Horsepower	60	80	90	110-120	140	140	150	160-165	200
Cu. In. Displacement	67.58	89.70	95.5	153	181	194	230	250	292
No. of Cyls.	4	4	4	4	4	6	6	6	6
Bore	2.76	2.99	3.032	3.87	4.00	3.56	3.87	3.87	3.87
Stroke	2.83	3.19	3.307	3.25	3.60	3.25	3.25	3.53	4.12
Compression Ratio	8.5 to 1	9.5 to 1	9.5 to 1	8.5 to 1	8.5 to 1	8.5 to 1	8.5 to 1	8.5 to 1	8.1 to 1
Compression Pressure ③	135 psi	140 psi	170 psi	140 psi	140 psi	140 psi	140 psi	140 psi	140 psi
Point Gap	.016	.019	.016-.019	.022	.022	.016	.016	.016	.016
Point Dwell	56°-60°	49°-55°	53-57°	31°-34°	31°-34°	31°-34°	31°-34°	31°-34°	31°-34°
Point Spring Tenson	19-23 Oz.	19-23 Oz.	19-23 Oz.	19-23 Oz.	19-23 Oz.	19-23 Oz.	19-23 Oz.	19-23 Oz.	19-23 Oz.
Spark Plug Type	AC44F	AC44XL	AC-R42XL	NOTE 4 AC-CR44N	NOTE 4-11 AC-CR44N	NOTE 4 AC-CR44N	NOTE 4 AC-CR44N	NOTE 2-4-5-11 AC-CR44N	NOTE 4 AC-CR44N
Plug Gap	.025	.025	.032	.035	.035	.035	.035	.035	.035
Timing at Idle RPM	TDC	2° ATDC	2° BTDC	NOTE 7 8° BTDC	6° BTDC	10° BTDC	6° BTDC	6° BTDC	8° BTDC
Max RPM at WOT	4500-4800	4500-4800	4500-4800	3900-4300	4200-4600	3700-4100	3900-4300	3900-4300	3900-4300
Idle RPM	650	650	650	500-600	500-600	500-600	500-600	500-600	500-600
Firing Order	Figure 1	Figure 2	Figure 2	Figure 3	Figure 3	Figure 4	Figure 4	Figure 4	Figure 4
Fuel Required	← 93 Research Octane Minimum - DO NOT USE Lead-Free or No-Lead Fuels →								
Fuel Pump Pressure	1¾-3½ psi	1¾-3½ psi	1¾-3½ psi	3½-4½ psi	3-5 psi	3½-4½ psi	3½-4½ psi	3½-4½ psi	3-5 psi
Electrical System	← 12 Volt Negative Ground →								
Battery Rating	70 Amp	70 Amp	70 Amp	70 Amp	70 Amp	70 Amp	70 Amp	70 Amp	70 Amp
Oil Pressure @ 2000 RPM	50-60		45 psi min @ 4000 RPM	35 psi	30-55 psi	35 psi	35 psi	30-55 psi	30-55 psi
Oil Pan Cap w/Filter	5.3 pints	5 Qts.	5 Qts.	4 Qts.	4 Qts.	5 Qts.	5 Qts.	5 Qts.	6 Qts.
Alternator Rating	15 Amp	22 Amp	22 Amp	32 or 42 Amp	32 or 42 Amp	32 or 42 Amp	32 or 42 Amp	32 or 42 Amp	32 Amp
Valve Lash	Int .005 Hot Exh .008 Hot	Int .008 Hot Exh .010 Hot	Int .008 Hot Exh .010 Hot	¾ Turn Down From "O" Lash	¾ Turn Down From "O" Lash	¾ Turn Down From "O" Lash	¾ Turn Down From "O" Lash	¾ Turn Down From "O" Lash	¾ Turn Down From "O" Lash

Model	888	190	215	225	225II-TR	250	255 II-TR	270	310	325	390
Horsepower	188	190	215	225	225	250	255	270	310	325	390
Cu. In. Displacement	302	283	302	327	302	327	351	350	409	427	482
No. of Cyls.	8	8	8	8	8	8	8	8	8	8	8
Bore	4.00	3.87	4.00	4.00	4.00	4.00	4.00	4.00	4.31	4.25	4.25
Stroke	3.00	3.00	3.00	3.25	3.00	3.25	3.50	3.48	3.50	3.76	4.25
Compression Ratio	8.5 to 1	8.0 to 1	9.0 to 1	8.1 to 1	8 to 1	8.8 to 1	8 to 1	8.8 to 1	7.8 to 1	8.8 to 1	10 to 1
Compression Pressure (3)	150 psi	140 psi	150 psi	140 psi	150 psi	150 psi	150 psi	150 psi	140 psi	150 psi	170 psi
Point Gap	.017	.016	.017	.016	.017	N.A.	.017	N.A.	.016	N.A.	N.A.
Point Dwell	26°-31°	28°-32°	26°-31°	28°-32°	26°-31°	N.A.	26°-31°	N.A.	28°-32°	N.A.	N.A.
Point Spring Tension	17-21 Oz.	19-23 Oz.	17-21 Oz.	19-23 Oz.	17-21 Oz.	N.A.	17-21 Oz.	N.A.	19-23 Oz.	N.A.	N.A.
Spark Plug Type	NOTE 13 C83T	NOTE 6 AC-CR43K	NOTE 13 C83T	NOTE 6 AC-CR43K	AC-C83T or Champion F-10	NOTE 8 AC-V40K	AC-C83T or Champion F-82	NOTE 8 AC-V40K	AC-43N	NOTE 8 AC-V40NK	AC-WR41N
Plug Gap	.030	.035	.030	.035	.030	Polar Gap	.030	Polar Gap	.035	Polar Gap	.035
Timing at Idle RPM	10° BTDC	Note 1	Note 9	Note 1	10°BTDC	10° BTDC	10° BTDC	10° BTDC	12° BTDC	10° BTDC	10° BTDC
Max. RPM at W.O.T	3800-4200	3700-4100	3800-4200	3800-4200	3800-4200	3800-4200	3800-4200	3800-4200	4500	3800-4200	3800-4200
Idle RPM	550-600	550-600	550-600	550-600	550-600	550-600	550-600	550-600	550-600	550-600	550-600
Firing Order	Figure 7	Figure 5	Figure 7	Figure 5	Figure 7	Figure 5	Figure 7	Figure 5	Figure 5	Figure 5	Figure 5
Fuel Required	93 Research Octane Minimum - DO NOT USE Lead-Free or No Lead Fuels										Premium Fuel
Fuel Pump Pressure	3-6psi	5¼-6½psi	3-6psi	4-7psi	3-6 psi	4-7 psi	3-6 psi	4-7psi	5¼-6½psi	4-7psi	4-7psi
Electrical System	12 Volt Negative Ground										
Battery Rating	70 Amp	70 Amp	70 Amp	70 Amp	72 Amp/Hr.	70 Amp	72 Amp/Hr.	70 Amp	90 Amp	90 Amp	90 Amp
Oil Pressure @ 2000 RPM	30-55 psi	35 psi	30-55 psi	30-55 psi	30-55 psi	30-55 psi	30-55 psi	30-55 psi	35 psi	30-70 psi	30-70 psi
Oil Pan Cap. w/Filter	6 Qts.	5 Qts.	7 Qts.	Note 2	6 Qts.	7 Qts.	5 Qts.	7 Qts.	5 Qts.	Approx. 8 Qts.	Approx. 8 Qts.
Alternator Rating	42 Amp	42 Amp	32 or 42 Amp	32 or 42 Amp	42 Amp	32 Amp	42 Amp	42 Amp	42 Amp	32 or 42 Amp	32 or 42 Amp
Valve Lash	N.A.	¾ Turn Down from "O" Lash	N.A.	¾ Turn Down from "O" Lash	N.A.	¼ Turn Down from "O" Lash	N.A.	¾ Turn Down from "O" Lash	Int. 008 Hot Exh. 018 Hot	¾ Turn Down from "O" Lash	¾ Turn Down from "O" Lash

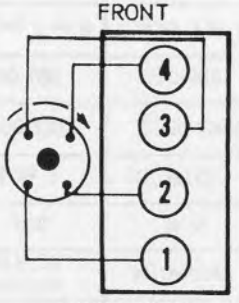
METRIC CONVERSION: 1" = 25.4mm; 1 Cu. In. = 16.39 Cu/Cm or 1.639 Liters; 1 psi = .07031 Kg/Sq. Cm.; 1 Qt. = .946 Liter

Model	30	55	215	225*	225 §	250	255	270	325	390
Horsepower	30	55	215	225	225	250	255	270	325	390
Cu. In. Displacement	67.58	67.58	302	327	302	327	351	350	427	482
Number of Cyl.	4	4	8	8	8	8	8	8	8	8
Bore	2.76	2.76	4.00	4.0	4.00	4.0	4.00	4.00	4.25	4.25
Stroke	2.83	2.83	3.00	3.25	3.00	3.25	3.50	3.48	3.76	4.25
Compression Ratio	8.5 to 1	8.5 to 1	9.0 to 1	8 to 1	8 to 1	8.8 to 1	8 to 1	8.8 to 1	8.8 to 1	10 to 1
Compression Pressure ③	140 psi	140 psi	150 psi	140 psi	150 psi	150 psi	150 psi	150 psi	150 psi	170 psi
Point Gap	.016	.016	.017	N.A.	.017	N.A.	.017	N.A.	N.A.	N.A.
Point Dwell	56°-60°	56°-60°	26°-31°	N.A.	26°-31°	N.A.	26°-31°	N.A.	N.A.	N.A.
Point Spring Tension	19-23 Oz.	19-23 Oz.	17-21 Oz.	N.A.	17-21 Oz.	N.A.	17-21 Oz.	N.A.	N.A.	N.A.
Spark Plug Type	AC44F	AC44F	Autolite BTF-3M	AC-V-40K	AC-C83T or Champion F-10	AC-V-40K	AC-C83T or Champion F10	Note 8	Note 10	ACWR41N
Plug Gap	.025	.025	.030	N.A.	.030	N.A.	.030	Note 8	Note 10	.035
Timing at Idle RPM	0° TDC	2° ATDC	Note 9	10° BTDC	10° BTDC	10° BTDC	10° BTDC	10° BTDC	10° BTDC	10° BTDC
Max. RPM at WOT	2800-3000	4300-4500	3700-4200	3800-4200	3800-4200	3800-4200	3800-4200	3700-4200	3700-4200	3700-4200
Idle RPM	650	650	550-600	550-600	550-600	550-600	550-600	550-600	550-600	550-600
Firing Order	Figure 1	Figure 1	Figure 7 or 8	Figure 5 or 6	Figure 7	Figure 5 or 6	Figure 7	Figure 5 or 6	Figure 5 or 6	Figure 5 or 6
Fuel Required	← 93 Research Octane Minimum - DO NOT USE Lead-Free or No-Lead Fuels →									Premium Fuel
Fuel Pump Pressure	1¾-3½ psi	1¾-3½ psi	3-6 psi	4-7 psi	3-6 psi	4-7 psi	3-6 psi	4-7 psi	4-7 psi	4-7 psi
Electrical System	← 12 Volt Negative Ground →									
Battery Rating	70 Amp	70 Amp	70 Amp	70 Amp	72 Amp/Hr.	70 Amp	72 Amp/Hr.	70 Amp	90 Amp	90 Amp
Oil Pressure @ 2000 RPM	50-60 psi	50-60 psi	30-55 psi	30-55 psi	30-55	30-55 psi	30-55	30-55 psi	30-70 psi	30-70 psi
Oil Pan Cap. w/Filter	Approx. 4 Qts.	Approx. 4 Qts.	Approx. 7 Qts.	Approx. 6 Qts.	Approx. 6 Qts.	Approx. 6 Qts.	Approx. 7 Qts.	Approx. 6 Qts.	Approx. 7 Qts.	Approx. 7 Qts.
Alternator Rating	32 Amp	32 Amp	42 Amp	32 Amp	42 Amp	32 Amp	42 Amp	42 Amp	32 or 42 Amp	32 or 42 Amp
Valve Lash	Int.005 Cold Exh.008 Cold	Int.005 Cold Exh.008 Cold	N.A.	¾ Turn Down from "O" Lash	N.A.	¾ Turn Down from "O" Lash	N.A.	¾ Turn Down from "O" Lash	¾ Turn Down from "O" Lash	¾ Turn Down from "O" Lash

** Serial Nos. 2694014 and Below § Serial Nos. 3385721 and Up*

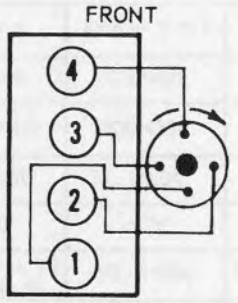
NOTES:

1. *Engines with Distributor Nos. 1111076 and 1111249 Are Timed at 8° BTDC, No. 1111297 at 4° BTDC, All Others at 12° BTDC.*
2. *Engines with Serial No. 2278646 and Below Use 5 Qts., Above Use 7 Qts.*
3. *Allowable Variation 20 psi between Compression Readings of Cylinders.*
4. *Engine May Be Using AC-C44N, Which Is Interchangeable with AC-CR44N.*
5. *Model 165 Engines (Serial No. 2771484 and Above) Use AC-R-44T Which Has Tapered Seat and 5/8" Hex.*
6. *Engines May Be Using AC-C43, Service Replacement is AC-CR43K.*
7. *Engines with Distributor Nos. 1112467 Are Timed at 6° BTDC.*
8. *Engines (Serial No. 2904164 and Below and Serial No. 3077496 thru 3077735) Use AC-V40K; Capping Not Required. Model 270 Engines (Serial No. 3077336 and Above) and 325 (Serial No. 3043030 and Above) Use AC-MR41T; Gap .035".*
9. *Engines with Distributor No. C9JF-12127-B or C9JF-12127-A, 12° BTDC; with Distributor No. D1JF-12127-JA or D1JF-12127-KA, 10° BTDC.*
10. *Engines (Serial No. 2762441 and below) Use AC-V40NK; Gapping Not Required. Engines (Serial No. 3042731 and Above) Use AC-MR41T; Gap .035".*
11. *For heavy-duty, high-speed applications, Use AC-CR43N.*
12. *For heavy-duty, high-speed applications, Use AC-R43T.*
13. *Autolite - BTF-3M.*



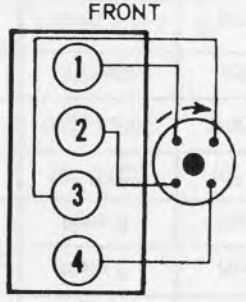
FIRING ORDER
1-3-4-2

Figure 1



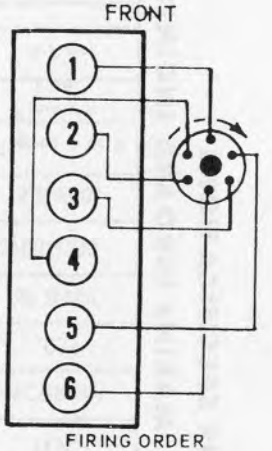
FIRING ORDER
1-3-4-2

Figure 2



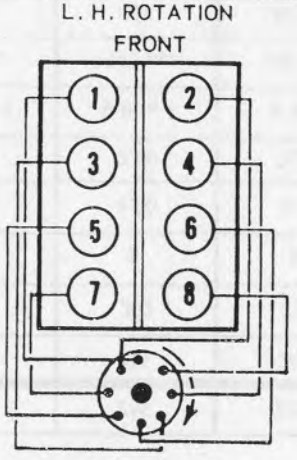
FIRING ORDER
1-3-4-2

Figure 3



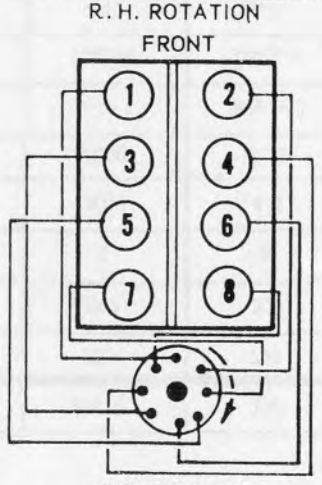
FIRING ORDER
1-5-3-6-2-4

Figure 4



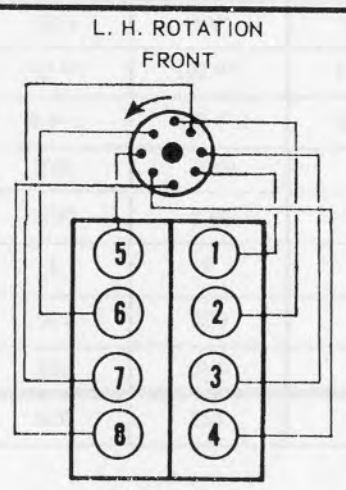
FIRING ORDER
1-8-4-3-6-5-7-2

Figure 5



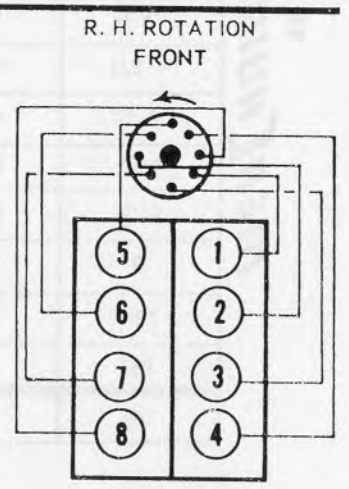
FIRING ORDER
1-2-7-5-6-3-4-8

ure 6



FIRING ORDER
1-3-7-2-6-5-4-8

Figure 7



FIRING ORDER
1-8-4-5-6-2-7-3

Fig

MODEL			110	120	140	140	150	160	165	200		
DISPLACEMENT CU. IN.			153	153	181	194	230	250	250	292		
CYLINDER BORE:												
Diameter			3.8745-3.8775		3.9995-4.0075	3.5630-3.5660	3.8745 - 3.8775					
Out of Round		Production	.0005 Max.									
		Service	.002 Max.									
Taper	Production	Thrust Side	.0005 Max.									
		Relief Side	.0005 Max.									
	Service		.005 Max.									
PISTON: Clearance												
Production			.0005-.0015			.0006 .0010	.0005-.0015			.0026-.0032		
Service			.0025 Max.							.0045 Max.		
PISTON RING: COMPRESSION												
Groove Clearance	Production	Top	.0012-.0027							.0020-.0040		
		2nd	.0012-.0032							.0020 .0040		
	Service	Top	.0012 .0037							.0020 .0040		
		2nd	.0012 .0042							.0020 .0050		
Gap	Production	Top	.010-.020									
		2nd	.010-.020									
	Service	Top	.010-.030									
		2nd	.010-.030									
PISTON RING: OIL												
Groove Clearance	Production		.000-.005							.0005 .0055		
	Service				.000-.006					.0005 .0065		
Gap	Production		.015-.055									
	Service		.015-.065									

MODEL			110	120	140	140	150	160	165	200		
PISTON PIN:												
Diameter			.9270-.9273									
Clearance		Production	.0015-.00025							.00025 .00035		
		Service	.001 Max.									
Fit in Rod			.0008-.0016 Interference									
CRANKSHAFT:												
Main Journal	Diameter		All 2.2983 2.2993									
	Taper	Production	.0002 Max.									
		Service	.001 Max.									
	Out of Round	Production	.0002 Max.									
		Service	.001 Max.									
Main Bearing Clearance	Production		.0003- .0029			.0008- .0034	.0003- .0029			.0008- .0034		
	Service		.004 Max.									
Crankshaft End Play			.002-.006 Max.									
Crankpin	Diameter		1.999 2.000		2.099 2.100	1.999 2.000						
	Taper	Production	.0003 Max.									
		Service	.001 Max.									
	Out of Round	Production	.0002 Max.									
		Service	.001 Max									
Rod Bearing Clearance		Production	.0007 .0027		.0007 .0028	.0007-.0027				.0007 .0028		
		Service	.004 Max.									
Rod Side Clearance			.0085 .0135		.009 .013	.0008- .0014	.0085-.0135					

MODEL			110	120	140	140	150	160	165	200		
CAMSHAFT:												
Lobe Lift ±.002" (Int. & Exh.)			.1914	.2325	.2525	.1914		.2297		.2525		
Journal Diameter			1.8682-1.8692									
Camshaft Runout			.0015 Max.									
VALVE SYSTEM:												
Lifter			Hydraulic									
Rocker Arm Ratio			1.75 to 1									
Valve Lash (Int. & Exh.)			¾ Turn Down from "O" Lash									
Face Angle		Intake	45°									
		Exhaust	45°							46°		
Seat Angle (Int. & Exh.)			46°									
Seat Runout (Int. & Exh.)			.002 Max.									
Seat Width		Intake	1/32-1/16				1/32-3/32			1/32-1/16		
		Exhaust	1/16-3/32									
Stem Clearance	Production	Int.	.0010-.0027									
		Exh.	.0015-.0032									
	Service	Int.	.0037 Max.									
		Exh.	.0052 Max									
Springs	Free Length		2.08		—	2.03	1.90					
	Pressure lbs. @ in.	Closed	78-86 @ 1.66		83 @1.66	84-92 @ 1.66	54-64 @ 1.66			85-93 @1.69		
		Open	170-180 @ 1.26		175 @1.26	163-173 @ 1.330	170-184 @ 1.330	180-192 @ 1.27		174-184 @ 1.30		
	Installed Height ±1/32"	Intake	1.6562									
		Exhaust	1.6562							1.625		
Damper	Free Length		1.94		—	—	—	—	—	1.94		
	Approx. # of Coils		4		—	—	—	—	—	4		

INTERNAL ENGINE SPECIFICATIONS

V-8 ENGINES

MODEL			190	888	215	225-TR	225	250	255-TR	270	310	325	390
DISPLACEMENT CU. IN.			283	302	302	302	327	327	351	350	409	427	482
CYLINDER BORE:													
Diameter			3.8745 3.8775	4.0004 4.0040			3.9995- 4.0025		4.0004- 4.0036	3.995- 4.0025	4.3120 4.3150	4.2495-4.2525	
Out of Round		Production	.0005 Max.	.001 Max.									
		Service	.002 Max.	.005 Max.			.002 Max.		.005 Max.	.002 Max.			
Taper	Production	Thrust Side	.0005 Max.										
		Relief Side	.001 Max.										
	Service		.005 Max.										
PISTON: Clearance													
Production			.0005- .0011	.0018- .0026			.0005- .0011	.0010- .0016	.0018- .0026	.0016- .0026	.0016 .0020	.0034- .0044	.0040- .0050
Service			.0025 Max.	.0018- .0026			.0025 Max.	.0030 Max.	.0018- .0026	.0026 Max.	.0030 Max.	.0044 Max.	.0050 Max.
PISTON RING: COMPRESSION													
Groove Clearance	Production	Top	.0012- .0027	.002- .004			.0012- .0027	.0012- .0032	.002- .004	.0012- .0032	.0017- .0032	.0018- .0038	.0018- .0038
		2nd	.0012 .0032	.002- .004			.0012- .0032	.0012- .0032	.002- .004	.0012- .0027	.0017- .0032	.0018- .0038	.0018- .0038
	Service	Top	.0012- .0037	.002- .004			.0012- .0037	.0012- .0042	.002- .004	.0012- .0042	.0017- .0042	.0018- .0048	.0018- .0048
		2nd	.0012- .0042	.002- .004			.0012- .0042	.0012- .0042	.002- .004	.0012- .0037	.0017- .0042	.0018- .0048	.0018- .0048
Gap	Production	Top	.013-.023	.010-.020			.013-.023	.010-.020					
		2nd	.013-.025	.010-.020			.013-.025		.010- .020	.013-.023	.010-.020		
	Service	Top	.013-.033	.010-.020			.013-.033	.010-.030	.010-.020	.010-.030			
		2nd	.013-.035	.010-.020			.013-.035		.010- .020-	.013-.040	.010-.030		
PISTON RING: OIL													
Groove Clearance	Production		.000-.005	"Snug"			.000-.005	.002-.007	"Snug"	.000-.005	.0005- .0065	.002- .0035	.002- .0035
	Service		.000-.006	"Snug"			.000-.006	.002-.008	"Snug"	.000-.006	.0005- .0075	.002-.0045	
Gap	Production		.015-.055	.015-.069	.015-.055						.010-.020	.010-.023	
	Service		.015-.065	.015-.069	.015- .055		.015-.065		.015- .055	.015-.065	.010-.030	.010-.033	

MODEL/HORSEPOWER			190	888	215	225II-TR	225	250	255II-TR	270	310	325	390
PISTON PIN:													
Diameter			.9270-.9273	.9119-.9124			.9270-.9273		.9119-.9124		.9895-.9898		
Clearance		Production	.00015-.00025	.0002-.0004			.00015-.00025	.00025-.00035	.0003-.0005	.00025-.00035			
		Service	.001 Max	.0008 Max.			.001 Max.		.0008 Max.	.001 Max.			
Fit in Rod			.0008-.0016 Interference										
CRANKSHAFT:													
Main Journal	Diameter		2.2988 2.2998	2.2482 2.2490			#1-2-3-4 2.4484-2.4493 #5 2.4479 2.4488		2.9994 3.0002		#1-2-3-4 2.4977-2.4987 #5 2.4980-2.4990	#1-2-3-4 2.7481-2.7490 #5 2.7478 2.7488	
	Taper	Production	.0002 Max.	.0003 Max.			.0002 Max.		.0003Max. Per In.	.0002 Max.			
		Service	.001 Max.	.0003 Per in.			.001 Max.			.001 Max.			
	Out of Round	Production	.0002 Max.	.0004			.0002 Max.		.0004 Max.	.0002 Max.			
		Service	.001 Max.				.001 Max.			.001 Max.			
Main Bearing Clearance	Production		.0008-.0018	#1 .0001-.0018 others .0005-.0024			#1-2-3-4 .0008-.0020 #5 .0018-.0034	#1-2-3-4 .0008-.0024 #5 .0010-.0026	.0008-.0026	#1-2-3-4 .0008-.0024 #5 .0010-.0026	#1-2-3-4 .0006-.0032 #5 .0018-.0034	#1-2-3-4 .0013-.0025 #5 .0015-.0031	
	Service		.004 Max.	Same as Production			.004 Max.		Same as Production	.004 Max.			
Crankshaft End Play			.002-.006	.004-.008			.003-.011		.004-.008	.003-.011	.004-.012	.006-.010	
Connecting Rod Journal	Diameter		1.999-2.000	2.1228-2.1236			1.999-2.000 S/N2399397 & Below; 2.099-2.100 S/N2399398 & Up	2.099-2.100	2.3103-2.3111	2.099-2.100	2.199-2.200		
	Taper	Production	.0003 Max.	.0004 Per In.			.0003 Max.		.0004 Per In.	.0003 Max.			
		Service	.001 Max.				.001 Max.			.001 Max.			
	Out of Round	Production	.0002 Max.	.0004			.0002 Max.		.0004	.0002 Max.			
		Service	.001 Max.				.001 Max.			.001 Max.			
Rod Bearing Clearance	Production		.0007-.0028	.001-.0015			.0007-.0028		.001-.0015	.0007-.0028	.0009-.0030	.0007-.0028	
	Service		.004	.0008-.0026			.004 Max.		.0008-.0026	.004 Max.			
Rod Side Clearance			.008-.014	.010-.020			.009-.013		.010-.020	.019-.025		.019-.025	

MODEL/HORSEPOWER			190	888	215	225-TR	225	250	255-TR	270	310	325	390
CAMSHAFT:													
Lobe Lift - .002"		Int.	.222	.260		.278	.260		.278	.260	.2813	.272	
		Exh.		.278		.283	.273		.283	.273	.2649	.282	
Journal Diameter			1.8682 1.8692	#1 2.0805-2.0815 #2 2.0655-2.0665 #3 2.0505-2.0515 #4 2.0355-2.0365 #5 2.0205-2.0215			1.8682 1.9692		#1 2.0805-2.0815 #2 2.0655-2.0665 #3 2.0505-2.0515 #4 2.0355-2.0365 #5 2.0205-2.0215	1.8682 1.9692	1.8687 1.8692	1.9487 1.9497	
Camshaft Runout			.0015 Max.	.005 Max.			.0015 Max.		.005 Max.	.0015 Max.			
VALVE SYSTEM:													
Lifter			Hydraulic								Mechanical	Hydraulic	
Rocker Arm Ratio			1.5 to 1	1.6-1			1.5 to 1		1.6 to 1	1.5 to 1	1.75 to 1	1.70 to 1	
Valve Lash (Int. & Exh.)			¼ Turn Down from "O" Lash	N.A.			3/4 Turn Down from "O" Lash		N.A.	¼ Turn Down from "O" Lash	INT. .008 Hot EXT. .018 Hot	3/4 Turn Down from "O" Lash	
Face Angle	Intake		45°	44°			45°		44°	45°			
	Exhaust		45°	44°			45°		44°	46°	45°	46°	
Seat Angle (Int. & Exh.)			46°	45°			46°		45°	46°			
Seat Runout (Int. & Exh.)			.002 Max.	.0015 Max.			.002 Max.		.0015 Max.	.002 Max.			
Seat Width	Intake		1/32-1/16	1/16-5/64		.060	1/32-1/16		.080	1/32-1/16			
	Exhaust		1/16-3/32	1/16-5/64			1/16-3/32			1/16-3/32		3/32-1/8	
Stem Clearance	Production	Int.	.0010-.0027									.0010-.0025	
		Exh.	.0016-.0033	.0015-.0032			.0010-.0027		.0015-.0032			.0012-.0027	
	Service	Int.	.0037	.0010 .0027			.0037		.0010-.0027	.0037		.0035	.0037
		Exh.	.0053	.0015- .0032			.0047		.0015-.0032	.0047	.0052	.0047	
Springs	Free Length		2.03	2.07			2.08		2.07	2.08	2.01	2.09	
	Pressure lbs. @ in.	Closed	78-86 @ 1.660	71-79 @ 1.790			76-84 @ 1.70		71-79 @ 1.790	78-86 @ 1.66	78-86 @ 1.626	94-106 @ 1.88	—
		Open	170-180 @ 1.260	190-210 @ 1.340			194-206 @ 1.25		190-210 @ 1.340	170-180 @ 1.26	184-196 @ 1.230	303-327 @ 1.38	—
	Installed Height ± 1/32"	Intake	1-5/32	1¾-1-13/16			1-5/32		1¾-1-13/16	1-21/32	1-1/16	1-7/8	
		Exhaust	1-5/32	1¾-1-13/16			1-5/32		1¾-1-13/16	1-21/32	1-1/16	1-7/8	
Damper	Free Length		1.94	—			1.94		—	1.94		1.94-2.00	—
	Approx. # of Coils		4	—			4		—	4	3½	3¾	—

INTERNAL ENGINE SPECIFICATIONS

MerCruiser 60, 80 and 90 Engines

Model			60	80	90
Displacement Cu. In.			67.58	89.70	95.5
Cylinder Sleeve					
Diameter			2.7481-2.7589	2.9921-3.0031	3.0315 3.0425
Out of Round			.002 Max.		
Taper			.005 Max.		
Cylinder Height (Above Cyl. Block)			.003-.005	.006-.008	
Piston: Clearance			.0035 Max.		
Piston Ring: Compression					
Groove Clearance			.0015-.0035		
Piston Ring: Oil					
Groove Clearance			.001 - .006		
Piston Pin:					
Diameter			.7087	.7874	
Clearance			.0035 Max.		
Fit in Rod			Interference		
Crankshaft:					
Main Journal	Diameter		1.8110	2.125	
	Taper		.001 Max.		
	Out of Round		.001 Max.		
Main Bearing Clearance			.001-.003	.0015-.0031	
Crankshaft End Play			.0018-.0075	.0018-.0091	
Rod Bearing Clearance			.001-.003	.0015-.0031	

Model			60	80	90
Rod Side Clearance			.004-.010		
Crankpin	Diameter		1.731	1.8898	
	Taper		.001 Max.		
	Out of Round		.001 Max.		
Camshaft:					
Lobe Lift ±.002"	Intake		.2059	.1979	.1979
	Exhaust		.2109	.1595	.1979
Camshaft End Play			.0018-.0075	.002-.0045	
Journal Diameter			1.4961	1.6535	
Camshaft Runout			.0015 Max.		
Valve System:					
Lifter			Mechanical		
Valve Lash	Intake		.005	.008	
	Exhaust		.008	.010	
Face Angle	Intake		45°		
	Exhaust		45°		
Seat Angle (Int. & Exh.)			45°		
Seat Runout (Int. & Exh.)			.002 Max.		
Seat Width	Intake		.055	.099	.067
	Exhaust		.067	.098	.067
Stem Clearance	Intake		.001-.003		
	Exhaust		.0015-.0045		
Springs	Free Length		1.65	1.890	2.127
	Pressure lbs. @ in.	Closed	30.8	48.4	54.4
		Open	39.6	50.6	60 5
Damper	Free Length		-	1.520	1.814
	Approx. # of Coils		-	5	6

V-8 TORQUE SPECIFICATIONS

Fastener Location	MerCruiser 190		MerCruiser 888 215		MerCruiser 225		MerCruiser 225II-TR		MerCruiser 250		MerCruiser 255II-TR	
	Size	Torq. Ft. Lbs.	Size	Torq. Ft. Lbs.	Size	Torq. Ft. Lbs.	Size	Torq. Ft. Lbs.	Size	Torq. Ft. Lbs.	Size	Torq. Ft. Lbs.
Camshaft Sprocket	5/16-18	20	3/8-16	43	5/16-18	20	3/8-16	43	5/16-18	20	3/8-16	43
Camshaft Thrust Plate			1/4-20	8			¼-20	8			¼-20	8
Crank shaft Damper	7/16-20	60	5/8-18	80	7/16-20	60	5/8-18	80	7/16-20	60	5/8-18	80
Carburetor	5/16-24	12	5/16-24	11	5/16-24	20	5/16-24	11			5/16-24	11
Connecting Rod Cap	11/32-24	33	5/16-24	24	11/32-24	33	5/16-24	24	3/8-24	45	3/8-24	40
Coupler	7/16-20	60	7/16-20	60	7/16-20	60	N.A.				N.A.	
Cylinder Head	7/16-14	65	7/16-14	70	7/16-14	65	7/16-14	70	7/16-14	65	½-13	108
Distributor Hold-Down	3/8-16	20	5/16-18	15	3/8-16	20	5/16-18	15	3/8-16	20	5/16-18	15
Drive Plate			5/16-18	18			5/16-18	18			5/16-18	18
Exhaust Manifold	3/8-16	21	3/8-16	25	3/8-16	21	3/8-16	25			3/8-16	25
Flywheel			7/16-20	80	7/16-20	60	7/16-20	80	7/16-20	60	7/16-20	80
Flywheel Housing to Block	3/8-16	21	7/16-14	40	3/8-16	21	7/16-14	40	3/8-16	20	7/16-14	40
Flywheel Cover to Housing			1/4-20	6	1/4-20	6	¼-20	6	1/4-20	6	¼-20	6
Front Mount	3/8-16	21	7/16-14	30	3/8-16	21	7/16-14	30	3/8-16	21	7/16-14	30
Fuel Pump	3/8-16	30	3/8-16	22	3/8-16	30	3/8-16	22	3/8-16	30	3/8-16	22
Intake Manifold	3/8-16	30	3/8-16	25	3/8-16	30	3/8-16	25	3/8-16	30	3/8-16	25
Main Bearing Cap	7/16-14	65	7/16-14	65	7/16-14	75	7/16-14	65	7/16-14	75	½-13	100
Oil Cooler to Housing			5/16-18	11	5/16-18	11	N.A.		5/16-18	11	N.A.	
Oil Filter Valve	1/4-20	6	N.A.				N.A.				N.A.	
Oil Filter Bolt	1/2-20	23	N.A.		1/2-20	23	N.A.				N.A.	
Oil Pan Screw	1/4-20	7	1/4-20	7			¼-20	7			¼-20	7
Oil Pan Screw	5/16-18	11	5/16-18	10			5/16-18	10			5/16-18	10
Oil Drain Plug	1/2-20	23	1/2-20	15* 20	1/2-20	20	½-20	15	1/2-20	20	½-20	15
Oil Pump	7/16-14	7	3/8-16	25	7/16-14	65	3/8-16	25	7/16-14	65	3/8-16	25
Oil Pump Cover	1/4-20	7	1/4-20	12	1/4-20	6	1/4-20	12	1/4-20	6	¼-20	12
Oil Pump Pickup Tube			5/16-18	14			5/16-18	14			3/8-16	22
Rear Mount			7/16-14	45			N.A.				N.A.	
Rocker Arm Cover	1/4-20	4	1/4-20	4	1/4-20	5	¼-20	4			¼-20	4
Spark Plugs	14mm	23	18mm	18	14mm	25	18mm	18	14mm	25	18mm	18
Starter Motor	3/8-16	33	3/8-16	25			3/8-16	25			3/8-16	25
Thermostat Housing	5/16-18	11	5/16-18	15			5/16-18	15			5/16-18	15
Thermostat Housing	3/8-16	20	5/16-18	15			5/16-18	15			5/16-18	15
Timing Chain or Gear Cover	1/4-20	7	5/16-18	13	1/4-20	6	5/16-18	13	1/4-20	6	5/16-18	13
Transmission Support Brg.			N.A.				N.A.				N.A.	
Transmission to Housing			7/16-14	50			N.A.				N.A.	
Water Pump	3/8-16	30	5/16-18	14	3/8-16	30	5/16-18	14	3/8-16	30	5/16-18	14

METRIC CONVERSION: 1 Ft. Lb. = .138mkg

**Steel Pan*

V-8 TORQUE SPECIFICATIONS

Fastener Location	MerCruiser 270		MerCruiser 310		MerCruiser 325		MerCruiser 390	
	Size	Torq. Ft. Lbs.	Size	Torq. Ft. Lbs.	Size	Torq. Ft. Lbs.	Size	Torq. Ft. Lbs.
Camshaft Sprocket	5/16-18	20	5/16-18	18	5/16-18	20	5/16-18	20
Camshaft Thrust Plate					5/16-18	20	5/16-18	20
Camshaft Damper	7/16-20	60			1/2-20	85	1/2-20	85
Carburetor					5/16-18	11	5/16-18	11
Connecting Rod Cap	3/8-24	45	3/8-24	40	3/8-24	50	7/16-20	65
Coupler								
Cylinder Head	7/16-14	65	7/16-14	65	7/16-14	80	7/16-14	80
Distributor Hold-Down	3/8-16	20			3/8-16	20	3/8-16	20
Drive Plate					3/8-16	35	3/8-16	35
Exhaust Manifold	3/8-16	20	3/8-16	20	3/8-16	20	3/8-16	20
Flywheel	7/16-20	60	7/16-20	60	7/16-20	65	7/16-20	65
Flywheel Housing to Block	3/8-16	20	3/8-16	20	3/8-16	20	3/8-16	20
Front Mount	1/4-20	6			1/4-20	6	1/4-20	6
Fuel Pump	3/8-16	30	3/8-16	30	3/8-16	20	3/8-16	20
Intake Manifold	3/8-16	30	3/8-16	30	3/8-16	30	3/8-16	30
Main Bearing Cap	7/16-14	75	1/2-13	95	1/2-13	110	1/2-13	110
Oil Cooler to Housing					5/16-18	11	5/16-18	11
Oil Filter Bolt			1/2-20	23				
Oil Pan	1/4-20	7	1/4-20	7	5/16-18	11	5/16-18	11
Oil Pan	5/16-18	10	5/16-18	10				
Oil Pan Drain Plug	1/2-20	20	1/2-20	23				
Oil Pump	7/16-14	65	7/16-14	65	7/16-14	65	7/16-14	65
Oil Pump Cover	1/4-20	6	1/4-20	7	1/4-20	6	1/4-20	6
Rear Mount					7/16-14	50	7/16-14	50
Rocker Arm Cover			1/4-20	3	1/4-20	4	1/4-20	4
Spark Plugs ▲	14mm	25	14mm	25	14mm	25	14mm	25
Starter Motor					7/16-14	50	7/16-14	50
Timing Chain or Gear Cover					1/4-20	6	1/4-20	6
Transmission Support Bearing					7/16-14	50	7/16-14	50
Transmission to Housing					7/16-14	50	7/16-14	50
Water Pump	3/8-16	30	3/8-16	30	3/8-16	30	3/8-16	30

▲ *Torque Tapered Seat Spark Plugs without Gaskets to 15 Ft. Lbs.*

METRIC CONVERSION: 1 Ft. Lb. = .138mkg

IN-LINE TORQUE SPECIFICATIONS

Fastener Location	MerCruiser 60 HP		MerCruiser 80 & 90 HP		MerCruiser 110,120,140,150, 160,165 &200 HP	
	Size	Torq. Ft. Lbs.	Size MM Dia. x Pitch	Torq. Ft. Lbs.	Size	Torq. Ft. Lbs.
Alternator Flywheel		35				
Block Water Drain Adaptor			10 x 1.5	11		
Camshaft Sprocket		14.5				
Camshaft Thrust Plate			8 x 1.25	6	1/4-20	6
Camshaft Cover Plate			8 x 1.25	15		
Carburetor Mounting					5/16-24	12
Crankshaft Pulley					5/16-24	18
Crankshaft Sprocket			12 x 1.25	50		
Connecting Rod Cap		21	9 x 1.25	33	11/32-24	33
Connecting Rod Cap					3/8-24	40
Coupling to Flywheel		25		33	7/16-20	60
Cylinder Head		43	11 x 1.5	56	1/2-13	93
Distributor Clamp		13		6	3/8-16	20
Exhaust Manifold Elbow			5/16-18	8		
Fuel Pump		13	8 x 1.25	14		
Flywheel			9 x 1.25	34		
Flywheel Housing to Block		33		38	3/8-16	21
Front Mount to Block					3/8-16	21
Main Bearing Cap		43	10 x 1.5	45	7/16-14	65
Manifold to Head		15	8 x 1.25	15	3/8-24	23
Oil Pan (Side)			7 x 1.0	7	1/4-20	7
Oil Pan (End)					5/16-18	10
Oil Pan Drain Plug			18 x 1.5	18	1/2-20	23
Oil Pump Cover			7 x 1.0	15	1/4-20	6
Oil Pump to Block				6-13	5/16-18	10
Oil Pump Pickup			7 x 1.0	18	1/4-20	5
Rocker Arm Cover			9 x 1.25	3	1/4-20	4
Rocker Shaft Support			8 x 1.25	18		
Rocker Shaft		13				
Spark Plugs ▲		13	14 x 1.25	21	14mm	25
Starter Motor		16	10 x 1.25	40	3/8-16	37
Timing Chain Tensioner			6 x 1.0	7		
Timing Chain Guide			7 x 1.0	9		
Timing Gear Cover			7 x 1.0	9	1/4-20	6
Water Pump to Block					5/16-18	15

▲*Torque Tapered Seat Spark Plugs without Gaskets to 15 Ft. Lbs.*

METRIC CONVERSION: 1 Ft. Lb. = .138mkg

GIMBAL HOUSING TORQUE SPECIFICATIONS

Gimbal Housing Location	MerCruiser 60-thru-90 Torque Ft. Lbs.	Late MerCruiser 90 Torque Ft. Lbs.	MerCruiser I-thru-165-888 Thread	MerCruiser I-thru-165-888 Torque Ft. Lbs.	MerCruiser II-thru-225 Thread	MerCruiser II-thru-225 Torque Ft. Lbs.	MerCruiser 215 Thread	MerCruiser 215 Torque Ft. Lbs.	MerCruiser III-270-325-390 Thread	MerCruiser III-270-325-390 Torque Ft. Lbs.	MerCruiser III-TR Thread	MerCruiser III-TR Torque Ft. Lbs.
Gimbal Housing Seal Retaining Covers, Screw		20-30*					1/4-20	12 (4)				
Steering Lever Coupler Screw, Nut			3/8-24	20 (1)	5/16-24	20 (1)	7/16-20	35 (1)	3/8-24	30 (1)		
Gimbal Ring to Upper Swivel Shaft, Screw		20	5/16-18	20 (1)			7/16-18	20 (1)	3/8-16	20 (1)	5/16-18	20(1)
Steering Lever to Upper Swivel Shaft, Nut	35 (1)	30-35	7/16-20	45-50			7/16-20	45-50			7/16-20	45-50(1)
Hydraulic Connector to Gimbal Housing Stud, Nut			1/4-28	10 (2)	1/4-28	10 (2)	1/4-28	10 (2)	1/4-28	10 (2)	1/4-28	10(2)
Top Hydraulic Connector to Gimbal Housing, Screw							1/4-20	12 (1)				
Hydraulic Connector to Top Connector, Tubing							3/8-24	140-160*(2)				
Oil Hose Retaining Clamp								10-15* (4)		25* (4)		10-15*(4)
Exhaust Bellows Retaining Clamp	12 (2)	30-40 In. Lbs.		35-38*				35* (2)				35*(2)
Universal Joint Bellows Retaining Clamp	12 (2)	30-40 In. Lbs.		35-38*		12 (2)		35* (2)		35* (2)		35*(2)
Shift Bellows Clamp				35-38*		12 (1)		35* (1)				
Valve Guide Cover to Bell Housing, Screw							1/4-28	15 (3)	1/4-28	15 (4)	1/4-28	15(3)
Bell Housing to Gimbal Ring, Hinge Pin	40 (2)	40 Ft. Lbs.					5/8-18	60 (2)	3/4-16	75 (2)	5/8-18	60 (2)
Bell Housing Stud to Drive Shaft Housing, Nut	40 (4)		7/16-20	50 (6)			1/2-20	75-85 (6)	5/8-18	100 (6)	1/2-20	80(6)
Reservoir Cover to Transom Plate, Screw							5/16-18	20 (8)	5/16-18	20 (11)	5/16-18	20(8)
Exhaust Cover to Transom Plate, Screw							5/16-24	15 (15)			5/16-24	12(15)
Exhaust Cover to Transom Plate, Screw							5/16-18	15 (2)			5/16-18	12 (2)
Mount Brackets to Flywheel Housing, Screw		12					5/8-18	100 (2)				
Hydraulic Pump Bracket, Screw	14 (3)		5 16-24	14 (3)	5/16-24	20 (3)	5/16-24	20 (6)	5/16-18•	20 (4)	5/16-18	20(4)
Steering Link Rod, Nut or Bolt to Ride-Guide	30 (1)	Tight-Back Off 1/4-Turn	3/8-24	20 (1)			3/8-24	20 (1)			3/8-24	20(1)
Gimbal Housing Stud to Transom Plate, Nut			1/2-13	20-25 (2)			1/2-20	25-30 (8)	1/2-20	25-30 (6)	1/2-20	25-30(8)
Transom Plate Carriage Bolt, Nut	20-25 (4)	5/16-24-20	1/2-13	20-25 (2)	1/2-20	20 -25 (8)			1/2-20	25-30 (2)		
Transom Plate to Gimbal Housing, Screw	20-25 (4)	1/4-28-12	7/16-14	20-25 (2)								
Gimbal Housing Stud, Nut			7/16-20	20-25 (2)								
Bearing Support Housing to Transmission, Screw									7/16-14	40-45 (8)		
Transmission to Flywheel Housing, Screw									7/16-14	40-45 (6)		
Mount Brackets to Transmission, Screw									7/16-14	40-45 (2)		
Gimbal Housing to Steering Lever Housing, Screw					1/2-13	75 (6)						
Steering Link Rod Bolts, Steering Lever Housing					1/2-20	75 (2)						
Top Pivot Bolt, Nut					5/8-18	100 (1)						
Shift Cable to Core Wire Support, Nut			5/16	15 (1)	5/16	15 (1)						
Upper and Lower Steering Arm, Screw					3/8-24	30□(2)						
Clamp Nut Cover to Inner Transom Plate, Screw					5/16-18	20 (6)						
Exhaust Elbow, Screw			3/8-16	20-25 (3)								20-25(6)
Engine Mount Nut, Bolt			1/2-20	60 (2)								
Reverse Lock Valve, Screw			5/16-18	14 (2)		14 (2)		14 (2)		14(2)		14(2)
Shift Cutout Lever Arm Spring Retainer, Screw		10-32 (5)	5/16-18	50-75* (1)		50-75*						

• *Or 5/16-24* **In. Lbs.* (1), (2), (3), *Etc. = Quantity* □*Tab Washered*

DRIVE SHAFT HOUSING TORQUE SPECIFICATIONS

Drive Shaft Housing Location	60 -thru- 90	MerCruiser I-thru-165 and 888		MerCruiser II-thru-225		MerCruiser 215		MerCruiser III-thru-390		MerCruiser II-TR	
	Torque Ft. Lbs.	Thread	Torque Ft. Lbs.	Thread	Torque Ft. Lbs.	Thread	Torque Ft. Lbs.	Thread	Torque Ft. Lbs.	Thread	Torque Ft. Lbs.
Drive Shaft Housing to Gear Housing Stud, Nut	40 (4)	7/16-20	35 (5)	7/16-20	40 (8)	7/16-20	35 (6)	9/16-18	60 (6)	7/16-20	35(1)
Bell Housing to Drive Shaft Housing Stud, Nut	40	7/16-20	50 (6)			½-20	80(6)	5/8-11	100(6)	½-20	75-85(6)
Crankshaft Cover, Screw						1/4-28	15 (3)				
Drive Shaft Housing Back (Rear) Cover, Screw				1/4-20	12 (6)	3/8-16	20 (4)	3/8-16	20 (2)	3/8-16	20(4)
Drive Shaft Housing Front Cover, Screw						3/8-16	20 (4)	7/16-14	30 (2)		
Drive Shaft Housing Front Cover Stud, Nut								3/8-24	20 (7)		
Drive Shaft Housing Top Cover, Screw	20 (4)	3/8-16	20 (4)	3/8-16	30 (5)	3/8-16	20 (4)			3/8-16	20 (4)
Drive Shaft Housing Bearing Retainer Stud, Nut								7/16-20	30 (4)		
Drive Shaft Housing Threaded Retainer								4 1/4-16	200 (1)		
Drive Shaft Housing Bearing Cone Retainer, Nut								1-3/4-16	250(1)		
Universal Joint Shaft Pinion, Nut	50 (1)	5/8-18	85 (1)	7/8-14	200 (1)	3/4-16	150 (1)	1-14	200 (1)	1-14	200 (1)
Universal Joint Shaft, Nut						3/4-16	150 (1)				
Universal Joint Cover, Retainer	150 (1)	3-7/8-16	200 (1)								
Drive Shaft Pinion, Nut				3/4-16	150 (1)						
Drive Shaft Housing Assembly, Nut					250						
Drive Shaft Gear Retainer, Nut						7/8-14	75 (1)‡				
Driven Gear Preload at Prop Shaft							95-132				
Driven Gear without Prop Shaft							45-57				
Drive Shaft Preload									25-5▶		
Drive Shaft Ball Bear. Ret. to Gear Hsg., Screw				5/16-18	20 (4)						
Upper Drive Shaft Gear, Nut (Up to 1970 Models)		5/8-18	85 (1)								
Upper Drive Shaft Preload	26-44*		26-44*								
Pinion Bear. Retainer to Drive Shaft Hsg., Screw				3/8-16	30 (8)						
Rack Guide to Drive Shaft Housing, Screw				1/4-20	12 (4)						
Valve Guide to Drive Shaft Housing, Screw						10-32	30* (3)			10-32	30* (3)
Rear Pinion Bearing Retainer, Special Nut						2-3/8-16	250 (1)				
Rear Bearing Preload							5-7				
Front Pinion Bearing Retainer, Special Nut						2-1/8-16	250 (1)				
Front Bearing Preload							5-7				
Over-All Preload at Prop Shaft							●				
Ratchet Screw Nut						1/4-28	15 (1)				
Shift Shaft to Drive Shaft Hsg., Threaded Bushing						9/16-12	50 (2)				
Shift Link Rod Assembly, Nut						1/4-28	15 (1)				
Water Pocket Cover, Screw	12 (4)	1/4-20	30-40* (4)								
Water Pump Body, Screw	5-8 (4)										
Upper Drive Impeller Shaft	40 (1)										
Trim Tab Bolt	180* (1)		180* (1)		180* (1)				180* (1)	7/16-14	180*(1)
Drive Shaft Lock Nut	100 (LH)										

* *In. Lbs.* • *Left Hand Thread* ▶ *New: 15-5 Serviceable* ● *115-160 for MC 215E; 105-142 for MC 215H* (1), (2), (3), *Etc.=Quantity* ‡*Back Off 1/8-Turn*

GEAR HOUSING TORQUE SPECIFICATIONS

Gear Housing Location	60 -thru- 90	MerCruiser I-thru-165 and 888		MerCruiser II-thru-225		MerCruiser 215		MerCruiser III-thru-390		MerCruiser II-TR	
	Torque Ft. Lbs.	Thread	Torque Ft. Lbs.	Thread	Torque Ft. Lbs.	Thread	Torque Ft. Lbs.	Thread	Torque Ft. Lbs.	Thread	Torque Ft. Lbs.
Gear Housing to Drive Shaft Housing Screw		3/8-16	28 (1).	7/16-14	50 (7)	½-13	50 (1).	½-13	50 (1)	½-13	50(1)
				7/16-14	50 (1)						
				¼-20	12 (3)						
Gear Housing Stud to Drive Shaft Housing, Nut						7/16-20	35 (1)			7/16-20	35(1)
Gear Case Cover, Retainer Spool	250 (1)	4-3/8-16	250 wo/Tab	4-3/8-16	250 (1)	5-1/8-16	250 (1)	5½-16	250 (1)	5-1/8-16	200(1)
			150 w/Tab								
Gear Housing Stud Bearing Retainer, Nut								3/8-24	30 (4)		
Gear Housing to Drive Shaft Housing Stud, Nut								9/16-18	60 (1)	7/16-20	35(6)
								7/16-20	35 (1)		
Gear Housing Preload at Drive Shaft								(New) 35±5			
								(Serviceable) 15±5			
Prop Shaft Preload without Drive Shaft							18-20				
Trim Tab to Gear Housing, Screw	275*	7/16-14	180* (1)			7/16-14.	180* (1)	7/16-14.	180* (1)	7/16-14	180*(1)
Lower Gear Bearing Cups, Retainer				3-7/8-16	200 (1)						
Forward and Reverse Gear, Locknut				1-3/4-16	150*(2)						
Gear Housing Pinion, Nut	◁	5/8-18.	60-80 (1).	1¼-1	150 (1)	3/4-16□	150 (1).	7/8-14	175 (1)	¾-16	150(1)
Water Pump Housing Stud, Nut (Aluminum)		¼-28	50-60* (2)								
		5/16-24.	50-60* (1)								
Water Pump Housing Screw (Aluminum)		¼-20	50-60* (1)								
Water Pump Housing Stud, Nut (Plastic)		¼-28	25-30*(2)								
(Plastic)		5/16-24	35-40*(1)								
Water Pump Housing Screw (Plastic)		¼-20	15-20*(1)								
Propeller Shaft, Nut		3/4-16	40±5§ (1)		40±5 (1)		40±5 (1)		40±5 (1)	1-14	40±5(1)
Oil and Water Adaptor, Screw	144* (3)										

* *In. Lbs.* • *Swagged* □ *Tab Washered* § *Adjusted to Tab Space*

◁ *50 Ft. Lbs. for "60" Model; 60 Ft. Lbs. for "80" and "90"* (1), (2), (3), *Etc. = Quantity*

IGNITION SPECIFICATIONS

Engine Model	60	80	90	110 120	(4) 140	(6) 140	150	160 165	190	200	225II-TR 255II-TR	888 215	225	310	250	270	325	390
Condenser	.25 to .29 MFD	.21-.25 MFD		.18-.25 MFD											Thunderbolt Ignition			
Coil	Coil Has Internal Resistor										Coil Has External Resistor							
Coil Max. Operating Amps.	.5*										.9*							
Coil Primary Resistance (Ohms) Minimum	3.9										.9							
Coil Primary Resistance (Ohms) Maximum	4.8										1.2							
Coil Secondary Resistance (Ohms)	6000-7700										7500-10,500							
Coil Secondary Continuity*	49-58*										53-63*							
Resistor (Ohms)									1.3-1.7									
Spark Plug Type Spark Plug Gap Point Dwell Point Spring Tension Timing	Refer to "Tuneup Specifications"																	

** Figures for C-91-25213 Magneto Analyzer Only*

ALTERNATOR SPECIFICATIONS

Identification Number	Ground	Rotation*	Field Current		Cold Output 5000 RPM	Hot Output
			Amperes	Volts		
1100619	N	CCW	1.9-2.3	12	40 Amps.	42 Amps.
1100721	N	CCW	2.2-2.6	12	30 Amps.	32 Amps.
1100806	N	CCW	2.2-2.6	12	30 Amps.	32 Amps.
1100912	N	CCW	4.1-4.5	12	37 Amps.	42 Amps.

** Rotation Is Dependent Upon Engine Rotation and Fan Type.*

CARBURETOR SPECIFICATIONS

Carburetor Model		MD	RBS	B-BC	BC	2GC	2GC	2GC	2GV
Carburetor No.				7025183 7025184	7020994 7020996 7024180 7024181	7020993 7028086	7025188 7026088	7028188 7040080 7040081 7042183	7040082 7040083 7040084
Adjustment		See Section 4							
Float Level	Primary	1/64	3/8 ± 1/32	See Note 1	1-9/32	5/8	5/8	5/8	5/8
	Secondary								
Float Toe	Primary								
	Secondary								
Float Drop	Primary			1-3/4	1-3/4	1-29/32	1-29/32	1-24/32	1-7/8
	Secondary								
Pump Rod Location									
Pump Rod			.000 to .015			1-5/32	1-1/8	1-5/32(3)	1-1/8
Fast Idle (Bench)			1½ to 2½ Turns		See Note 2	See Note 2			
Choke Rod									
Air Valve Dashpot									
Vacuum Break								Flush	Flush
Unloader			.110 ± .003	.230	.230	.160	.080	.080	.080
Air Valve Lockout									
Throttle Valve Lockout									
Secondary Opening									
Secondary Closing									
Sec. Metering Rod									
A.V. Spring Wind Up									
Choke Setting			4P Lean	Index	Index	Index	Index	Index	

NOTES: (1) 1-9/32 with 1/32 Shim between Needle and Float (2) Turn Screw In to Contact Low Step of Cam.
(3) 1-7/32 on 7042183

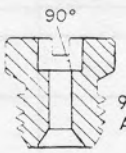
Carburetor Model		4GC	4GC	4GC	4GC	4MV	4MV	4MV	Holley	Holley
Carburetor No.		7020995	7023180	7023183	7025180	7027080	7029280 7029285 7040283 7041280	7037082	4160 6407 6576 (4 Bore)	2300C 6317-1 (2 Bore)
Adjustment				See Section 4						
Float Level	Primary	1-3/8	1½	1-3/8	1-11/32	¼	¼	¼	Bottom of Sight Plug Hole	±1/32"
	Secondary	1-11/32	1-9/16	1-11/32	1-3/8					
Float Toe	Primary	11/16		11/16						
	Secondary	9/16		9/16						
Float Drop	Primary	1-3/8	2¼	1-3/8	1-3/8					
	Secondary	1-3/8	2¼	1-3/8	1-3/8					
Pump Rod Location		Outer	Outer	Outer		Inner	Inner	Inner		
Pump Rod		1-1/32	1-3/32	1-1/16	1	9/32		9/32	.015-.002	.015-.062
Fast Idle (Bench)		See Note 2	See Note 2	See Note 2		2 Turns	2 Turns	2 Turns	.081	
Choke Rod		Flush	Flush	Flush	.050	.100	.100	.100	1-23/32 Bench	
Air Valve Dashpot						.030	.030	.030		
Vacuum Break					Flush	.150	.150	.150	.110	
Unloader		.120	.230	.130	.120	.300	.300	.300	.1875	.270-.160
Air Valve Lockout						.015	.015	.015	.015	
Throttle Valve Lockout					.110 .015					
Secondary Opening		.015	.020	.015		.070		.070		
Secondary Closing		.110	.020	.030		.020		.020		
Second Metering Rod						7/8		7/8		
A V Spring Windup						5/8		¾		
Choke Setting		3 N.L.	Index	Index	3 N.L.	1 Rod Diameter Interference	Electric	1 Rod Diameter Interference	Index	Index

NOTE: Turn Screw In to Contact Low Step of Cam.

MAIN METERING STANDARD JET SIZES

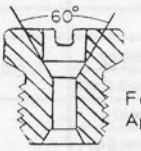
Do not identify main metering jets by the orifice size which is stamped on front of jet. It is possible to have 3 different jets with the same size orifice, as jets are available with 3 different approach angles. Figures, shown below, illustrate the approach angles that a jet may have. All 3 could have the same size orifice, although each one will allow a different amount of fuel to flow thru the carburetor.

When ordering replacement jets, order by part number and not by orifice size.



90° Approach Angle

Partial 60° Approach Angle



Full 60° Approach Angle

HIGH ALTITUDE PERFORMANCE - MERCRUISER ENGINES

High altitude performance tests have shown that very little performance improvement is realized by increased spark advance or carburetor recalibration. On the contrary, repropping the unit to run at its rated RPM has shown a significant increase in performance. Based on this testing, our general recommendation should be to "reprop the unit to its rated RPM in order to obtain maximum performance".

Any recommendation, other than changing props, to obtain rated RPM should be considered a special case and referred to the factory branch or area distributor for specific jet sizes and spark timing settings. These recommendations should not be made until the customer is fully aware of the following points:

1. Operating an engine with the above changes at lower elevation will cause engine failure.
2. Making the above changes (leaner jets and advanced spark timing) will result in increased fuel economy, but will not have a significant effect on performance.

STARTER SPECIFICATIONS

Identification Number	No Load Test						Brush Spring Tension
	Volts	Min. Amps.	Max. Amps.	Min. RPM	Max. RPM	Pinion Clearance	
1107259	10.6	49	76	6200	9400	.005-.050	40 Oz.
1107274	10.6	65	100	3600	5100	.005-.050	35 Oz.
1108361	9	55	85	3100	4900	.010-.140	35 Oz.
1108365	9	53	69	6400	8600	.010-.140	35 Oz.
1108391	9	55	85	3100	4900	.010-.140	35 Oz.
215E*	-	70	-	-	-	-	40 Oz.

* *Autolite Positive-Engagement Drive*

STARTER SPECIFICATIONS - 60-80-90 MODELS

Model	"60"	"80" & "90"
Length of Brushes (New)	.590	.547
Minimum Length of Brushes (Worn)	.295	.438
Diameter of Commutator (New)	1.319	1.437
Minimum Diameter of Commutator (Worn)	1.299	1.338
Mica Inserts, Undercut Depth	.020	.020
Clearance between Front Stop and Pinion in Action	.002 to .059	.020 to .099

CLOSED COOLING SYSTEMS

Engine Model	Cooling System	Capacity (Qts.)	Cap Pressure (Lbs.)
MCM 120-140	B-61086A2	9	14
MCM 165	B-61086A2	11	14
MCM 888	B-62472A1	17	14
MCM and MIE 225	B-62472A1	17	14
MCM and MIE 225	B-61418A1	20	13
MCM and MIE 225	B-55125A4	21	14
MCM and MIE 255	B-61804A1	22	14
MCM and MIE 270	B-55125A9	23	14
MCM and MIE 325	B-63107A1	28	14
MCM and MIE 325	B-61114A1	28	13
MCM and MIE 325	B-55125A9	31	14
MCM and MIE 390	B-55125A9	33	14

TORQUE SPECIFICATIONS
DIRECT DRIVE TRANSMISSION

Fastener Location	Size	Torque Ft./Lbs.
Pump to Adaptor	5/16-18 x 1½	17-22
Adaptor to Case	3/8-16 x 1¼	27-37
Valve Cover to Case	¼-20 x 5/8	8-11
Shift Lever to Valve	5/16-24	8-11
Bearing Retainer to Case	7/16-14 x 1¼	42-50
Output Shaft Nut	1-20	100-200
Cooler Return to Case	¾-14	25-35
Case Pipe Plug	1/8-27	7-12
Adaptor Pipe Plug	¼-18	12-20
Case Pipe Plug	3/8-18	17-27
Dipstick Assembly	¾-14	10-15

TORQUE SPECIFICATIONS
MERCRUISER II-TR TRANSMISSION

Fastener Location	Size	Torque (In./Lbs.)
Shift Arm to Control Shaft	¼-28	75
Control Valve Cap to Housing	¼-28	70-80
Reverse Lock Valve Cam Follower to Control Valve Cap	10-32	30
Allen Plug in Output Shaft	1/8	90
Oil Discharge Passage Plug	5/8	300
Relief Passage Plug	5/8	300
Allen Plug In Pump Housing	¼	192
Oil Pickup Tube Allen Screw	¼-28	90
Cooler Tube to Cooler Cover	½-20	125
Plug on Cooler Cover	3/8	252
Oil Cooler to Transmission	¼-28	85-95
Breather Vent		90
Output Housing to Transmission	5/16-18	204-228
Grease Fitting to Output Bearing Retainer		20
Control Valve to Transmission	5/16-18	204-228
Pump Housing to Transmission	5/16-18	125-135
Pump Cover to Pump Housing	¼-28	85-95
Reverse Band		120 and Back Off 1½ Turns
Actuating Motor to Bracket		90
Motor Bracket to Control Valve Housing	5/16-18	125-135
Reverse Lock Valve to Motor Bracket	¼-28	70
Output Bearing Retainer to Output Housing	¼-28	70

MERCRUISER

PROPELLER RECOMMENDATION CHART

Boat length can be used to select a propeller for initial trial. Correct propeller allows engine to turn recommended RPM and gives best performance. Because of many variables of boat design, only testing will determine best propeller.

Metric Conversion: 1" (inch) is equal to 2.54 centimeters (cm); 1' (foot) is equal to .305 meters (m).

Model (Engine Horsepower)	Stem Drive	Aluminum Propellers Part Numbers		Dia.	Pitch	No. of Blades	Approx. Boat Length	Speed MPH Range
		RH Rotation	LH Rotation					
		C-48-38396A1		10¾"	19"	3	Dual or 13'-15'	35-42
		C-48-38394A1		10¾"	17"	3	Dual or 13'-16'	29-36
		C-48-38086A1		10¾"	15"	3	13'-17'	24-31
60	60	C-48-38090A1		10¾"	13"	3	17'-19½'	21-26
		C-48-38094A1		10¾"	12"	3	19'-21'	19-23
RPM:		C-48-38098A1		10¾"	11"	3	21'-24'	12-21
4500-4800		C-48-33774A1		10¾"	10"	3	Houseboat	
		C-48-32386A3		13¾"	23"	2	Up to 15' §	41-47
		C-48-49632A3		13¾"	21"	2	Up to 16' §	38-42
		C-48-32746A3		13"	21"	3	Up to 16' §	38-42
		C-48-32388A3		13¾"	19"	2	15½-17'	33-39
80	80	C-48-32750A3		13"	19"	3	15½-17'	33-39
		C-48-32264A3		13"	17"	3	16-18'	28-34
		C-48-32390A3		14"	15"	3	17-19'	24-29
		C-48-32392A3		13½"	13"	3	19-21'	17-25
RPM:		C-48-35936A3		14"	11"	3	21-23' +	12-18
4500-4800		C-48-33242A3		14"	9½"	3	Work Boat	7-13
		B-48-52012A3		13"	25"	3	Up to 15' §	45-51
		B-48-52008A3		13"	23"	3	Up to 15' §	41-47
		B-48-32746A3		13"	21"	3	Up to 16'	37-43
		B-48-32750A3		13"	19"	3	14-17'	33-39
90	90	B-48-32264A3		13"	17"	3	15-18'	29-35
		B-48-32390A3		14"	15"	3	16-19'	24-30
		B-48-32392A3		13½"	13"	3	18-21'	19-25
RPM:		B-48-35936A3		14"	11"	3	20-23'	14-20
4500-4800		B-48-33242A3		14"	9½"	3	WB or HB	8-15
		* C-48-31448A3		13½"	25"	2	§	41-49
		* C-48-31450A3		13¾"	23"	2	§	47-55
		C-48-32386A3		13¾"	23"	2	§	47-55
		* C-48-32744A3		13"	21"	3	15-16½'	41-49
		C-48-32746A3		13"	21"	3	15-16½'	41-49
		* C-48-32748A3		13"	19"	3	16-18'	35-43
		C-48-32750A3		13"	19"	3	16-18'	35-43
		* C-48-31458A3		13"	17"	3	17-19'	29-37
110	I	C-48-32264A3		13"	17"	3	17-19'	29-37
		* C-48-31460A3		13½"	15"	3	18½-21'	23-31
		C-48-32390A3		13½"	15"	3	18½-21'	23-31
		* C-48-30394A3		13½"	13"	3	21-25'	17-25
		C-48-32392A3		13½"	13"	3	21-25'	17-25
		* C-48-30396A3		14"	11"	3	23-27'	13-21
		C-48-35936A3		14"	11"	3	23-27'	13-21
		* C-48-30398A3		14"	9½"	3	27'-Up +	8-18
RPM:		C-48-33242A3		14"	9½"	3	27'-Up +	8-18
3700-4100		* C-48-30400A3		14"	8½"	3	Work Boat	1-8
		B-48-36008A1		14½"	25"	3	Dual, Fast	43-50
		B-48-58426A1		15"	23"	3	16'-18'	35-42
		B-48-36010A1		14½"	23"	3	Dual, Fast	38-45
		B-48-58424A1		15¼"	21"	3	17'-19'	33-40
		B-48-49634A1		15"	21"	3	16'-18'	33-40
110	IA	B-48-58422A1		15½"	19"	3	18'-21'	28-35
		B-48-36014A1		15½"	19"	3	17'-19'	29-35
		B-48-36016A1		15¾"	17"	3	18½'-21'	24-31
		B-48-36018A1		16"	15"	3	20'-25'	19-26
		B-48-36020A1		16"	13"	3	23'-27'	15-21
RPM:		B-48-36022A1		16"	11"	3	Houseboat	8-17
3700-4100		B-48-36024A1		16"	9"	3	Work Boat	1-10

* *Bronze Material*

§ *Dual Motor Installation or Single Installation on Fast Boats*

\+ *Houseboat*

Model (Engine Horsepower)	Stern Drive	Aluminum Propellers Part Numbers		Dia.	Pitch	No. of Blades	Approx. Boat Length	Speed MPH Range
		RH Rotation	LH Rotation					
		B-48-36028A1		14½"	27"	3	Dual, Fast	42-48
		B-48-36008A1		14½"	25"	3	15'-17'	38-44
		B-48-58426A1		15"	23"	3	16'-18'	35-42
		B-48-36010A1		14½"	23"	3	16'-18'	35-42
		B-48-58424A1		15¼"	21"	3	17'-19'	33-40
		B-48-49634A1		15"	21"	3	17'-19'	33-40
120	IB	B-48-58422A1		15½"	19"	3	18'-21'	28-35
		B-48-36014A1		15½"	19"	3	18'-21'	28-35
		B-48-36016A1		15¾"	17"	3	20'-25'	23-29
		B-48-36018A1		16"	15"	3	23'-27'	18-24
		B-48-36020A1		16"	13"	3	26'-Plus	13-20
RPM:		B-48-36022A1		16"	11"	3	Houseboat	7-15
3900-4300		B-48-36024A1		16"	9"	3	Work Boat	1-9
		* C-48-31448A3		13½"	25"	2	§	50-60
		* C-48-31450A3		13¾"	23"	2	15-16½'	45-53
		C-48-32386A3		13¾"	23"	2	15-16½'	45-53
		* C-48-32744A3		13"	21"	3	16-18'	39-47
		C-48-32746A3		13"	21"	3	16-18'	39-47
		* C-48-32748A3		13"	19"	3	17-19'	33-41
		C-48-32750A3		13"	19"	3	17-19'	33-41
		* C-48-31458A3		13"	17"	3	18½-21'	27-35
140 (6 Cyl.)	I	C-48-32264A3		13"	17"	3	18½-21'	27-35
		* C-48-31460A3		13½"	15"	3	21-25'	21-29
		C-48-32390A3		13½"	15"	3	21-25'	21-29
		* C-48-30394A3		13½"	13"	3	23-27'+	16-24
		C-48-32392A3		13½"	13"	3	23-27'+	16-24
		* C-48-30396A3		14"	11"	3	27'-Up+	10-20
		C-48-35936A3		14"	11"	3	27'-Up+	10-20
		* C-48-30398A3		14"	9½"	3	Work Boat	3-12
RPM:		C-48-33242A3		14"	9½"	3	Work Boat	3-12
3700-4100		* C-48-30400A3		14"	8½"	3	Hvy.Wk.Boat	1-3
		B-48-36030A1		16"	25"	2	Dual, Fast	45-50
		B-48-36008A1		14½"	25"	3	Dual, Fast	45-50
		B-48-58426A4		15"	23"	3	16'-18'	40-46
		B-48-36010A1		14½"	23"	3	Dual, Fast	41-47
		B-48-58424A4		15¼"	21"	3	17'-20'	37-43
		B-48-49634A1		15"	21"	3	16'-18½"	37-43
140 (6 Cyl.)	IC	B-48-58422A4		15½"	19"	3	18'-21'	34-40
		B-48-36014A1		15½"	19"	3	17'-19½'	33-39
		B-48-36016A1		15¾"	17"	3	18½'-21'	27-35
		B-48-36018A1		16"	15"	3	20'-25'	22-29
		B-48-36020A1		16"	13"	3	23'-27'	16-24
RPM:		B-48-36022A1		16"	11"	3	Houseboat	10-18
3700-4100		B-48-36024A1		16"	9"	3	Work Boat	1-11
		B-48-36028A4		14½"	27"	3	15'-17' Dual	46-52
		B-48-36008A4		14½"	25"	3	15'-17'	43-49
		B-48-58426A4		15"	23"	3	16'-18'	40-46
		B-48-36010A4		14½"	23"	3	16'-18'	40-46
		B-48-58424A4		15¼"	21"	3	17'-20'	37-43
		B-48-49634A4		15"	21"	3	17'-20'	37-43
140 (4 Cyl.)	IB	B-48-58422A4		15½"	19"	3	18'-21'	34-40
		B-48-36014A4		15½"	19"	3	18'-21'	34-40
		B-48-36016A4		15¾"	17"	3	20'-25'	29-35
		B-48-36018A4		16"	15"	3	23'-27'	25-31
		B-48-36020A4		16"	13"	3	26' Plus	21-27
RPM:		B-48-36022A4		16"	11"	3	Houseboat	17-23
4200-4600		B-48-36024A4		16"	9"	3	Houseboat	Up to 17

* *Bronze Material*

§ *Dual Motor Installation or Single Installation of Fast Boats*

\+ *Houseboat*

Model (Engine Horsepower)	Stern Drive (Ratio)	Aluminum Propellers Part Numbers		Dia.	Pitch	No. of Blades	Approx. Boat Length	Speed MPH Range
		RH Rotation	LH Rotation					
		B-48-36032A1		16"	27"	2	Dual, Fast	55-61
		B-48-36028A1		14½"	27"	3	Dual, Fast	55-61
		B-48-36030A1		16"	25"	2	Dual or 16-18	48-57
		B-48-36008A1		14½"	25"	3	Dual or 16-18	48-57
		B-48-58426A1		15"	23"	3	17'-19'	41-50
		B-48-36010A1		14½"	23"	3	16'-18'	41-50
		B-48-58424A1		15¼"	21"	3	19'-21'	37-43
150	IC	B-48-49634A1		15"	21"	3	17'-19'	37-43
		B-48-58422A1		15½"	19"	3	20'-25'	33-39
		B-48-36014A1		15½"	19"	3	18½'-21'	33-39
		B-48-36016A1		15¾"	17"	3	20'-25'	27-35
		B-48-36018A1		16"	15"	3	23'-27'	22-29
		B-48-36020A1		16"	13"	3	26'-Plus	16-24
RPM:		B-48-36022A1		16"	11"	3	Houseboat	10-18
3900-4300		B-48-36024A1		16"	9"	3	Work Boat	1-11
		B-48-36032A1		15½"	27"	2	Dual, Fast	55-61
		B-48-36028A1		14½"	27"	3	Dual, Fast	55-61
		B-48-36030A1		16"	25"	2	Dual, Fast	48-57
		B-48-36008A1		14½"	25"	3	Up to 17'	48-57
		B-48-58426A1		15"	23"	3	17'-19'	41-50
		B-48-36010A1		14½"	23"	3	17'-19'	41-50
		B-48-58424A1		15¼"	21"	3	19'-21'	37-43
160	IC	B-48-49634A1		15"	21"	3	19'-21'	37-43
165		B-48-58422A1		15½"	19"	3	20'-25'	33-39
		B-48-36014A1		15½"	19"	3	20'-25'	33-39
		B-48-36016A1		15¾"	17"	3	23'-27'	27-35
		B-48-36018A1		16"	15"	3	26'-Plus	22-29
		B-48-36020A1		16"	13"	3	30'-Plus	16-24
RPM:		B-48-36022A1		16"	11"	3	Houseboat	10-18
3900-4300		B-48-36024A1		16"	9"	3	Work Boat	1-11
		B-48-36008A4		14¼"	25"	3	Dual, Fast	49-59
		B-48-58426A4		15"	23"	3	Up to 17'	45-54
		B-48-58424A4		15¼"	21"	3	17'-19'	41-49
		B-48-58422A4		15½"	19"	3	19'-21'	37-44
888	1.5:1	B-48-36016A4		15¾"	17"	3	20'-25'	32-40
		B-48-36018A4		16"	15"	3	22'-27'	27-35
		B-48-36020A4		16"	13"	3	26'-32'	22-29
RPM:		B-48-36022A4		16"	11"	3	30'-Plus	17-23
3800-4200		B-48-36024A4		16"	9"	3	HB+ or WB+	1-18
		B-48-33238A1	B-48-33237A1	16¾"	23"	2	16'-19'	47-58
		●B-48-33880A1	●B-48-33879A1	16¾"	21"	3		
		B-48-31680A1	B-48-31679A1	16¼"	21"	2	16'-19'	42-52
		●B-48-33882A1	●B-48-33881A1	16¾"	19"	3		
		B-48-31678A1	B-48-31677A1	16¾"	19"	2	18'-24'	37-46
190		●B-48-33884A1	●B-48-33883A1	16¾"	17"	3		
225	II 1.33:1	B-48-31676A1	B-48-31675A1	16¾"	17"	2	20'-27'	33-42
310		B-48-31674A1	B-48-31673A1	15"	17"	3	20'-27'	31-40
		●B-48-33886A1	●B-48-33885A1	16¾"	15"	3		
		B-48-31672A1	B-48-31671A1	16"	15"	3	24'-33'	26-37
		B-48-31670A1	B-48-31669A1	16¼"	13"	3	33' - Plus	20-32
RPM:		B-48-31668A1	B-48-31667A1	16¾"	11"	3	35' - Plus §	11-23
3700-4100		B-48-35426A1	B-48-35425A1	16¾"	9"	3	Work Barges	
		B-48-37780A1		20"	29"	3		
		B-48-37778A1	B-48-37779A1	20"	27"	3		
		B-48-37776A1	B-48-37777A1	20"	25"	3		
		B-48-37774A1	B-48-37775A1	20"	23"	3		
Heavy Duty	II 2:1	B-48-37772A1	B-48-37773A1	20"	21"	3		
		B-48-37770A1	B-48-37771A1	20"	19"	3		
		B-48-37768A1	B-48-37769A1	20"	17"	3		
RPM:		B-48-37766A1	B-48-37767A1	20"	15"	3		
3700-4100		B-48-37764A1	B-48-37765A1	20"	13"	3		

§ *Dual Motor Installation or Single Installation of Fast Boats*

● *"310" Model Only (Others for "190" and "225" Only)*

+WB = Work Boat; +HB = Houseboat

Model (Engine Horsepower)	Stem Drive (Ratio)	Aluminum Propellers Part Numbers		Dia.	Pitch	No. of Blades	Approx. Boat Length	Speed MPH Range
		RH Rotation	LH Rotation					
		B-48-54352A1	B-48-54353A1	15½"	31"	3	Dual	50-58
		B-48-53496A1	B-48-53497A1	15½"	29"	3	Dual	47-55
		B-48-49978A1	B-48-49979A1	15¾"	27"	3	16'-19'	43-51
		B-48-49974A1	B-48-49973A1	16"	25"	3	16'-19'	39-47
200	1.78:1	B-48-49972A1	B-48-49971A1	16-3/8"	23"	3	17'-21'	35-42
		B-48-33880A1	B-48-33879A1	16¾"	21"	3	18'-24'	30-37
		B-48-33882A1	B-48-33881A1	16¾"	19"	3	23'-28'	25-32
RPM:		B-48-33884A1	B-48-33883A1	16¾"	17"	3	25'-33'	20-27
3700-4200		B-48-33886A1	B-48-33885A1	16¾"	15"	3	Houseboat	15-22
		B-48-57270A1	B-48-57271A1	18"	29"	3	17'-19'	42-49
		B-48-57268A1	B-48-57269A1	18¼"	27"	3	17'-20'	39-46
		B-48-57266A1	B-48-57267A1	18¾"	25"	3	18'-21'	36-43
215-H		B-48-57264A1	B-48-57265A1	19¼"	23"	3	19'-23'	33-39
215-E	2:1	B-48-57262A1	B-48-57263A1	19½"	21"	3	21'-24'	29-35
		B-48-54726A1	B-48-54725A1	19"	19"	3	22'-26'	24-31
		B-48-54724A1	B-48-54723A1	19¼"	17"	3	23'-27'	19-26
		B-48-54722A1	B-48-54721A1	19¾"	15"	3	24'-29'	14-21
RPM:		B-48-54720A1	B-48-54719A1	20"	13"	3	26'-31'	9-16
3700-4200		B-48-54718A1	B-48-54717A1	20"	11"	3	WB+ or HB+	0-11
		B-48-54352A1	B-48-54353A1	15½"	31"	3	Dual	50-58
		B-48-53496A1	B-48-53497A1	15½"	29"	3	Dual, Fast	47-55
		B-48-49978A1	B-48-49979A1	15¾"	27"	3	16'-20'	43-51
		B-48-49974A1	B-48-49973A1	16"	25"	3	17'-24'	39-47
225	1.78:1	B-48-49972A1	B-48-49971A1	16-3/8"	23"	3	18'-26'	35-42
		B-48-33880A1	B-48-33879A1	16¾"	21"	3	23'-28'	30-37
		B-48-33882A1	B-48-33881A1	16¾"	19"	3	25'-33'	25-32
RPM:		B-48-33884A1	B-48-33883A1	16¾"	17"	3	Houseboat	20-27
3700-4200		B-48-33886A1	B-48-33885A1	16¾"	15"	3	Houseboat	15-22
		B-48-47712A1	B-48-47711A1	18¾"	29"	3	18-20'	42-49
		B-48-47710A1	B-48-47709A1	19"	27"	3	18-20'	39-46
		B-48-47708A1	B-48-47707A1	19¼"	25"	3	18-21'	36-43
		B-48-47706A1	B-48-47705A1	19¾"	23"	3	20-23'	33-39
250	III 2:1	B-48-47704A1	B-48-47703A1	20"	21"	3	22-25'	29-35
270		B-48-47702A1	B-48-47701A1	20"	19"	3	24-27'	24-31
		B-48-47700A1	B-48-47699A1	20"	17"	3	24-30'	19-26
		B-48-47698A1	B-48-47697A1	20"	15"	3	26-32'	14-21
RPM:		B-48-47696A1	B-48-47695A1	20"	13"	3	28-34'	9-16
3700-4200		B-48-47694A1	B-48-47693A1	20"	11"	3	WB+ or HB+ Over 36'	1-11
		B-48-47708A1	B-48-47707A1	19¼"	25"	3	18-22'	50-58
		B-48-47706A1	B-48-47705A1	19¾"	23"	3	21-24'	46-53
		B-48-47704A1	B-48-47703A1	20"	21"	3	23-26'	40-45
325	III 1.5:1	B-48-47702A1	B-48-47701A1	20"	19"	3	25-28'	35-42
		B-48-47700A1	B-48-47699A1	20"	17"	3	27-30'	29-37
		B-48-47698A1	B-48-47697A1	20"	15"	3	28-32'	23-31
		B-48-47696A1	B-48-47695A1	20"	13"	3	30-34'	18-25
RPM:		B-48-47694A1	B-48-47693A1	20"	11"	3	32-36'	14-20
3700-4200		B-48-47692A1	B-48-47691A1	20"	9"	3	WB+ or HB+ and over 36'	1-16

+ WB = Work Boat; +HB = Houseboat

Model (Engine Horsepower)	Stern Drive	Aluminum Propellers Part Numbers		Dia.	Pitch	No. of Blades	Approx. Boat Length	Speed MPH Range
		RH Rotation	LH Rotation					
325 RPM: 3700-4200	III 2:1	B-48-47712A1	B-48-47711A1	18¾"	29"	3	18-22'	42-49
		B-48-47710A1	B-48-47709A1	19"	27"	3	18-22'	39-46
		B-48-47708A1	B-48-47707A1	19¼"	25"	3	21-24'	36-43
		B-48-47706A1	B-48-47705A1	19¾"	23"	3	23-26'	33-39
		B-48-47704A1	B-48-47703A1	20"	21"	3	25-28'	29-35
		B-48-47702A1	B-48-47701A1	20"	19"	3	27-30'	24-31
		B-48-47700A1	B-48-47699A1	20"	17"	3	28-32'	19-26
		B-48-47698A1	B-48-47697A1	20"	15"	3	30-34'	14-21
		B-48-47696A1	B-48-47695A1	20"	13"	3	32-36'	9-16
		B-48-47694A1	B-48-47693A1	20"	11"	3	WB+ or HB+ Over 36'	1-11
390 RPM: 3700-4200	III 2:1	B-48-47712A1	B-48-47711A1	18¾"	29"	3	20-24'	42-49
		B-48-47710A1	B-48-47709A1	19"	27"	3	20-24'	39-46
		B-48-47708A1	B-48-47707A1	19¼"	25"	3	22-26'	36-43
		B-48-47706A1	B-48-47705A1	19¾"	23"	3	24-29'	33-39
		B-48-47704A1	B-48-47703A1	20"	21"	3	26-31'	29-35
		B-48-47702A1	B-48-47701A1	20"	19"	3	28-33'	24-31
		B-48-47700A1	B-48-47699A1	20"	17"	3	32-36'	19-26
		B-48-47698A1	B-48-47697A1	20"	15"	3	34-38'	14-21
		B-48-47696A1	B-48-47695A1	20"	13"	3	36-40'	9-16
		B-48-47694A1	B-48-47693A1	20"	11"	3	WB+ or HB+ and over 40'	0-11
225 II-TR RPM 3800-4200	II-TR 2:1	B-48-57270A1	B-48-57271A1	29"	18"	3	17-19'	48-55
		B-48-57268A1	B-48-57269A1	27"	18¼"	3	17-20'	45-52
		B-48-57266A1	B-48-57267A1	25"	18¾"	3	18-21'	42-49
		B-48-57264A1	B-48-57265A1	23"	19¼"	3	19-23'	39-45
		B-48-57262A1	B-48-57263A1	21"	19½"	3	21-24'	35-41
		B-48 63306A1	B-48-63305A1	19"	19¾"	3	22-26'	30-37
		B-48-63304A1	B-48-63303A1	17"	20"	3	23-27'	25-32
		B-48-54722A1	B-48-54721A1	15"	19¾"	3	24-29'	20-27
		B-48-54720A1	B-48-54719A1	13"	20"	3	26-35'	15-22
		B-48-54718A1	B-48-54717A1	11"	20"	3	WB+ or HB+ and over 35'	1-16
255 II-TR RPM 3800-4200	II-TR 2:1	B-48-57270A1	B-48-57271A1	29"	18"	3	17-20'	49-56
		B-48-57268A1	B-48-57269A1	27"	18¼"	3	18-21'	46-53
		B-48-57266A1	B-48-57267A1	25"	18¾"	3	19-22'	43-50
		B-48-57264A1	B-48-57265A1	23"	19¼"	3	20-24'	41-46
		B-48-57262A1	B-48-57263A1	21"	19½"	3	22-26'	36-42
		B-48-63306A1	B-48-63305A1	19"	19¾"	3	23-27'	31-38
		B-48-63304A1	B-48-63303A1	17'	20"	3	24-28'	26-33
		B-48-54722A1	B-48-54721A1	15"	19¾"	3	25-30'	21-28
		B-48-54720A1	B-48-54719A1	13"	20"	3	27-36'	15-23
		B-48-54718A1	B-48-54717A1	11"	20"	3	WB+ or HB+ and over 36'	1-17

+ WB=Work Boat; + HB = Houseboat

HIGH ALTITUDE PERFORMANCE - MERCRUISER ENGINES

High altitude performance tests have shown that very little performance improvement is realized by increased spark advance or carburetor recalibration. On the contrary, repropping the unit to run at its rated RPM has shown a significant increase in performance. Based on this testing, our general recommendation should be to "reprop the unit to its rated RPM in order to obtain maximum performance".

Any recommendation, other than changing props, to obtain rated RPM should be considered a special case and referred to the factory branch or area distributor for specific jet sizes and spark timing settings. These recommendations should not be made until the customer is fully aware of the following points:

1. Operating an engine with the above changes at lower elevation will cause engine failure.
2. Making the above changes (leaner jets and advanced spark timing) will result in increased fuel economy, but will not have a significant effect on performance.

BEARING PRELOAD TORQUES
MERCRUISER II-TR

Chart on Following Page Is Set Up for New Bearing Only.
For Old Bearing, Use Approximatly 50% of These Values.

Bearing Preload Torque	Specifications
Upper Drive Shaft Only (Located in Drive Shaft Housing)	10-20 In. Lbs.
Drive Shaft Housing Complete (Upper Drive Shaft and Universal Joint Shaft Recorded at Upper Drive Shaft)	Upper Drive Shaft Torque Plus 5-20 In. Lbs.
Propeller Shaft	Right Hand Rotation: 5-30 In. Lbs. Left Hand Rotation: 5-15 In. Lbs.
Drive Unit Overall Preload (Recorded from Propeller Shaft); Refer to "Explanation of Preload Chart", Below.	1.5 Multiplied by Drive Shaft Housing Complete Preload Torque, Plus Propeller Shaft Bearing Preload Torque, Plus 5-20 In. Lbs.

EXPLANATION of PRELOAD CHART

Before lower drive shaft bearing preload torque is measured, you must know how much combined bearing preload has already been applied to drive unit bearings. The drive shaft housing complete bearing preload is measured from upper drive shaft as illustrated in "Drive Shaft Housing Reassembly", Section 6.

Let's say that drive shaft housing over-all bearing preload is set at 25 in. lbs. Because preload readings now will be measured through gear housing from propeller shaft, and gear housing has a 1.5 to 1 gear ratio, drive shaft housing over-all bearing preload must be multiplied by 1.5 (example, Step 1, following). Preload reading then is 37.5 in. lbs., as measured from propeller shaft. If a fraction exists in the answer drop the fraction to make it 37 in. lbs. Add the propeller shaft bearing preload, determined in "Gear Housing Reassembly", Section 6, to drive shaft housing complete preload, measured from propeller shaft.

If propeller shaft preload is 17 in. lbs., total will be 54 in. lbs. (example, Step 2, following). This is the bearing preload torque on drive unit, measured from propeller shaft before gear housing to drive shaft housing nuts are tightened, which applies a preload to the lower drive shaft tapered roller bearings. Drive unit over-all preload torque is 5-20 in. lbs. above this value (chart example shaded area, following, is 59-74 in. lbs). To obtain over-all preload torque, tighten gear housing to drive shaft housing nuts evenly to maintain an even gap between housings. Tighten until bearing preload torque is within these limits (example, Step 3, following).

EXAMPLE, STEP 1

25 In. Lb. Drive Shaft Housing Complete Preload Torque, Measured from Upper Drive Shaft
x1.5 Gear Housing Gear Ratio
37.5 = 37 In. Lb. Drive Shaft Housing Complete Preload Torque, Measured from Propeller Shaft

EXAMPLE, STEP 2

37 In. Lb. Drive Shaft Housing Complete Preload Torque, Measured from Propeller Shaft
+17 In. Lb. Propeller Shaft Bearing Preload Torque
54 In. Lb. Drive Unit Preload Less Lower Drive Shaft Bearings

EXAMPLE, STEP 3

54 54 In. Lb. Drive Unit Preload Less Lower Drive Shaft Bearings
+5 +20 In. Lb. (Minimum and Maximum) Lower Drive Shaft Preload Only
59 74 In. Lb. (Minimum and Maximum) Over-all Drive Unit Preload at Propeller Shaft

OVERALL TORQUES at PROPSHAFT
MerCruiser 225-255TR Complete Drive Unit

PROPSHAFT TORQUE ONLY (as MEASURED)	DRIVE SHAFT HOUSING (COMPLETE) TORQUE (as MEASURED at UPPER DRIVE SHAFT)																											
	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
5	32/47	34/49	35/50	37/52	38/53	40/55	41/56	43/58	44/59	46/61	47/62	49/64	50/65	52/67	53/68	55/70	56/71	58/73	59/74	61/76	62/77	64/79	65/80	67/82	68/83	70/85
6	33/48	35/50	36/51	38/53	39/54	41/56	42/57	44/59	45/60	47/62	48/63	50/65	51/66	53/68	54/69	56/71	57/72	59/74	60/75	62/77	63/78	65/80	66/81	68/83	69/84	71/86
7	34/49	36/51	37/52	39/54	40/55	42/57	43/58	45/60	46/61	48/63	49/64	51/66	52/67	54/69	55/70	57/72	58/73	60/75	61/76	63/78	64/79	66/81	67/82	69/84	70/85	72/87
8	35/50	37/52	38/53	40/55	41/56	43/58	44/59	46/61	47/62	49/64	50/65	52/67	53/68	55/70	56/71	58/73	59/74	61/76	62/77	64/79	65/80	67/82	68/83	70/85	71/86	73/88
9	36/51	38/53	39/54	41/56	42/57	44/59	45/60	47/62	48/63	50/65	51/66	53/68	54/69	56/71	57/72	59/74	60/75	62/77	63/78	65/80	66/81	68/83	69/84	71/86	72/87	74/89
10	37/52	39/54	40/55	42/57	43/58	45/60	46/61	48/63	49/64	51/66	52/67	54/69	55/70	57/72	58/73	60/75	61/76	63/78	64/79	66/81	67/82	69/84	70/85	72/87	73/88	75/90
11	38/53	40/55	41/56	43/58	44/59	46/61	47/62	49/64	50/65	52/67	53/68	55/70	56/71	58/73	59/74	61/76	62/77	64/79	65/80	67/82	68/83	70/85	71/86	73/88	74/89	76/91
12	39/54	41/56	42/57	44/59	45/60	47/62	48/63	50/65	51/66	53/68	54/69	56/71	57/72	59/74	60/75	62/77	63/78	65/80	66/81	68/83	69/84	71/86	72/87	74/89	75/90	77/92
13	40/55	42/57	43/58	45/60	46/61	48/63	49/64	51/66	52/67	54/69	55/70	57/72	58/73	60/75	61/76	63/78	64/79	66/81	67/82	69/84	70/85	72/87	73/88	75/90	76/91	78/93
14	41/56	43/58	44/59	46/61	47/62	49/64	50/65	52/67	53/68	55/70	56/71	58/73	59/74	61/76	62/77	64/79	65/80	67/82	68/83	70/85	71/86	73/88	74/89	76/91	77/92	79/94
15	42/57	44/59	45/60	47/62	48/63	50/65	51/66	53/68	54/69	56/71	57/72	59/74	60/75	62/77	63/78	65/80	66/81	68/83	69/84	71/86	72/87	74/89	75/90	77/92	78/93	80/95
16	43/58	45/60	46/61	48/63	49/64	51/66	52/67	54/69	55/70	57/72	58/73	60/75	61/76	63/78	64/79	66/81	67/82	69/84	70/85	72/87	73/88	75/90	76/91	78/93	79/94	81/96
17	44/59	46/61	47/62	49/64	50/65	52/67	53/68	55/70	56/71	58/73	59/74	61/76	62/77	64/79	65/80	67/82	68/83	70/85	71/86	73/88	74/89	76/91	77/92	79/94	80/95	82/97
18	45/60	47/62	48/63	50/65	51/66	53/68	54/69	56/71	57/72	59/74	60/75	62/77	63/78	65/80	66/81	68/83	69/84	71/86	72/87	74/89	75/90	77/92	78/93	80/95	81/96	83/98
19	46/61	48/63	49/64	51/66	52/67	54/69	55/70	57/72	58/73	60/75	61/76	63/78	64/79	66/81	67/82	69/84	70/85	72/87	73/88	75/90	76/91	78/93	79/94	81/96	82/97	84/99
20	47/62	49/64	50/65	52/67	53/68	55/70	54/71	58/73	59/74	61/76	62/77	64/79	65/80	67/82	68/83	70/85	71/86	73/88	74/89	76/91	77/92	79/94	80/95	82/97	83/98	85/100
21	48/63	50/65	51/66	53/68	54/69	56/71	51/72	59/74	60/75	62/77	63/78	65/80	66/81	68/83	69/84	71/86	72/87	74/89	75/90	77/92	78/93	80/95	81/96	83/98	84/99	86/101
22	49/64	51/66	52/67	54/69	55/70	57/72	58/73	60/75	61/76	63/78	64/79	64/81	65/82	69/84	70/85	72/87	73/88	75/90	76/91	78/93	79/94	81/96	82/97	84/99	85/100	87/102
23	50/65	52/67	53/68	55/70	56/71	58/73	59/74	61/76	62/77	64/79	65/80	67/82	68/83	70/85	71/86	73/88	74/89	76/91	77/92	79/94	80/95	82/97	83/98	85/100	86/101	88/103
24	51/66	53/68	54/69	56/71	57/72	59/74	60/75	62/77	63/78	65/80	66/81	68/83	69/84	71/86	72/87	74/89	75/90	77/92	78/93	80/95	81/96	83/98	84/99	86/101	87/102	89/104
25	52/67	54/69	55/70	57/72	58/73	60/75	61/76	63/78	64/79	64/81	67/82	69/84	70/85	72/87	73/88	75/90	76/91	78/93	79/94	81/96	82/97	84/99	85/100	87/102	88/103	90/105
26	53/68	55/70	56/71	58/73	59/74	61/76	62/77	64/79	65/80	67/82	68/83	70/85	71/86	73/88	74/89	76/91	77/92	79/94	80/95	82/97	83/98	85/100	86/101	88/103	89/104	91/106
27	54/69	54/71	57/72	59/74	60/75	62/77	63/78	65/80	66/81	68/83	69/84	71/86	72/87	74/89	75/90	77/92	78/93	80/95	81/96	83/98	84/99	86/101	87/102	89/104	90/105	92/107
28	55/70	57/72	58/73	60/75	61/76	63/78	64/79	64/81	67/82	69/84	70/85	72/87	73/88	75/90	76/91	78/93	79/94	81/96	82/97	84/99	85/100	87/102	88/103	90/105	91/106	93/108
29	56/71	58/73	59/74	61/76	62/77	64/79	65/80	67/82	68/83	70/85	71/86	73/88	74/89	76/91	77/92	79/94	80/95	82/97	83/98	85/100	86/101	88/103	89/104	91/106	92/107	94/109
30	57/72	59/74	60/75	62/77	63/78	65/80	64/81	68/83	69/84	71/86	72/87	74/89	75/90	77/92	78/93	80/95	81/96	83/98	84/99	86/101	87/102	89/104	90/105	92/107	93/108	95/110

UPDATED and NEW SPECIFICATIONS

Specifications, which are not listed, following, have not been changed. Use old specifications.
For Model 225-S specifications, refer to 888 listing for engine (P. 8-2) and drive unit (PP 8-15, 8-16 and 8-17) specifications.

For Model 255 II-TRS specifications, refer to 255 II-TR listing for engine (P. 8-2), gimbal housing (P. 8-15) and drive shaft housing (P. 8-16) specifications. Gear housing specifications for 255 II-TRS (P. 8-33) are new.

SPARK PLUGS

Model	120 Serial No. 3825579 & Up	140 Serial No. 3826282 & Up	350
Spark Plug Type	AC-R43T	AC-R43T	AC-MR41T

TUNE-UP SPECIFICATIONS

Model	350 Inboard	400 Series Jet
Horsepower	350	N.A.
Cu. In. Displacement	454	454
Number of Cyl.	8	8
Bore	4.25	4.25
Stroke	4.00	4.00
Compression Ratio	8.5 to 1	8.6 to 1
Compression Pressure (Note 3)	150 PSI	150 PSI
Spark Plug Type	AC-MR41T	AC-MR41T
Plug Gap	.035	.035
Timing at Idle RPM	10° BTDC	10° BTDC
Max. RPM at WOT	3700-4200	4800-5200
Firing Order	1-8-4-3-6-5-7-2	1-8-4-3-6-5-7-2
Fuel Required	93 Research Octane Minimum - Do Not Use Lead-Free or No-Lead Fuels	
Fuel Pump Pressure	4.7 PSI	4.7 PSI
Electrical System	12-Volt Negative Ground	
Battery Rating	72 Amp/Hr.	72 Amp/Hr.
Oil Pressure at 2000 RPM	30-70 PSI	30-70 PSI
Oil Pan Cap. w/ Filter	Approx. 7 Qts.	Approx. 7 Qts.
Alternator Rating	42 Amp.	42 Amp.
Valve Lash	¾ Turn Down from "0" Lash	¾ Turn Down from "0" Lash
Idle RPM	550-600	800-850
Point Gap	----------	.017 (.432mm)
Point Dwell	----------	26° to 31°

INTERNAL ENGINE SPECIFICATIONS
V-8 ENGINES

MODEL				350	400 Series Jet
DISPLACEMENT CU. IN.				454	454
CYLINDER BORE					
Diameter				4.2500-4.2520	
Out of Round			Production	.001 Max.	
			Service	.002 Max.	
Taper	Production		Thrust Side	.0005 Max.	
			Relief Side	.001 Max.	
	Service			.005 Max.	
PISTON: Clearance					
Production				.0040-.0050	
Service				.006 Max.	
PISTON RING: COMPRESSION					
Groove Clearance	Production		Top	.0017-.0032	
			2nd	.0017-.0032	
	Service		Top	.0017-.0042	
			2nd	.0017-.0042	
Gap	Production		Top	.010-.020	
			2nd	.010-.020	
	Service		Top	.010-.020	
			2nd	.010-.020	
PISTON RING: OIL					
Groove Clearance	Production			.0011-.0075	
	Service			.0011-.0075	
Gap	Production			.010-.025	
	Service			.010-.025	

MODEL			350	400 Series Jet
PISTON PIN:				
Diameter			.9895-.9898	
Clearance	Production		.00045-.00055	
	Service		.001 Max.	
Fit in Rod			.0008-.0021	
CRANKSHAFT:				
Main Journal	Diameter		#1 2.7475-2.7484 #2-3-4 2.7481-2.7490 #5 2.7468-2.7478	#1-2-3-4 2.7481-2.7490 #5 2.7473-2.7483
	Taper	Production	.0002 Max. per In.	
		Service	.001 Max. per In.	
	Out of Round	Production	.0002 Max. per In.	
		Service	.001 Max. per In.	
Main Bearing Clearance	Production		#1 .0019-.0031 #2-3-4 .0013-.0025 #5 .0029-.0045	#1-2-3-4 .0013-.0025 #5 .0024-.0040
	Service			
Crankshaft End Play			.006-.010	
Connecting Rod Journal	Diameter		2.1985-2.1995	2.2000-2.1990
	Taper	Production	.0003 Max. per In.	
		Service	.001 Max. per In.	
	Out of Round	Production	.0002 Max. per In.	
		Service	.001 Max. per In.	
Rod Bearing Clearance	Production		.0014-.0030	
	Service		.0035 Max.	
Rod Side Clearance			.019-.027	

INTERNAL ENGINE SPECIFICATIONS V-8 ENGINES

MODEL				350	400 Series Jet
CAMSHAFT:					
Lobe Lift ± .002"			Int.	.2714	.29412
			Exh.	.2824	.29412
Journal Diameter				1.9487-1.9497	
Camshaft Runout				.0015 Max.	
CYLINDER HEAD:					
Gasket Surface Flatness				.003 in Any 6" or .007 Over-All Max.	
VALVE SYSTEM:					
Lifter				Hydraulic	
Rocker Arm Ratio				1.70 to 1	
Valve Lash (Int. & Exh.)				¾ Turn Down from "0" Lash	
Face Angle	Intake			45°	
	Exhaust			45°	
Seat Angle (Int. & Exh.)				46°	
Seat Runout (Int. & Exh.)				.002 Max.	
Seat Width	Intake			1/32-1/16	
	Exhaust			1/16-3/32	
Stem Clearance	Production		Int.	.0010-.0025	
			Exh.	.0012-.0027	
	Service		Int.	.0010-.0035	
			Exh.	.0012-.0037	
Springs	Free Length			2.10	
	Pressure Lbs. In.		Closed	74-86 per 1.88	
			Open	288-312 per 1.38	
	Installed Height ±1/32"		Intake	1.88	
			Exhaust	1.88	1.865
Damper	Free Length			1.86	
	Approx. No. of Coils			4	

V-8 TORQUE SPECIFICATIONS

Fastener Location	MerCruiser 350 and 400 Series Jet	
	Size	Torque Ft. Lbs.
Camshaft Sprocket	5/16-18	20
Camshaft Thrust Plate	5/16-18	20
Crankshaft Damper	½-20	85
Carburetor	5/16-18	11
Connecting Rod Cap	7/16-20	70
Cylinder Head	7/16-14	80
Distributor Hold-Down	3/8-16	20
Drive Plate	3/8-16	35
Exhaust Manifold	3/8-16	20
Flywheel	7/16-20	65
Flywheel Housing to Block	3/8-16	20
Front Mount	3/8-16	35
Fuel Pump	3/8-16	20
Intake Manifold	3/8-16	30
Main Bearing Cap	½-13	110
Oil Pan Screw	5/16-18	11
Oil Drain Plug	½-20	20
Oil Pump	7/16-14	65
Oil Pump Cover	¼-20	6
Rear Mount	7/16-14	50
Rocker Arm Cover	¼-20	4
Spark Plugs	14mm	15
Starter Motor	7/16-14	50
Thermostat Housing	3/8-16	30
Timing Chain or Gear Cover	¼-20	6
Transmission to Housing	7/16-14	50
Water Pump	3/8-16	30

METRIC CONVERSION: 1 Ft. Lb. = .138mkg

GEAR HOUSING TORQUE SPECIFICATIONS
II-TRS and II-TR MODELS

Gear Housing Location	MerCruiser II-TRS		MerCruiser II-TR	
	Thread	Torque Ft. Lbs.	Thread	Torque Ft. Lbs.
Gear Housing to Drive Shaft Housing Screw	½-13	50 (1)	½-13	50 (1)
Gear Housing Stud to Drive Shaft Housing, Nut	7/16-20	35 (1)	7/16-20	35 (1)
Gear Case Cover, Retainer Spool	4-3/8-16	■ (1)	5-1/8-16	§ (1)
Gear Housing to Drive Shaft Housing Stud, Nut	7/16-20	35 (6)	7/16-20	35 (6)
Trim Tab to Gear Housing, Screw	7/16-14	180*(1)	7/16-14	180*(1)
Gear Housing Pinion, Nut	¾-16	150 (1)	¾-16	150 (1)
Propeller Shaft, Nut	¾-16	40±5 (1)	1-14	40±5 (1)

**In. Lbs.* *(1), (2), (3), Etc. = Quantity*

■ *Tighten Cover until Specified Propeller Shaft Bearing Preload Is Obtained.*

§ *Serial No. 3786859 and Below - 200 Ft. Lbs.*
Serial No. 3786860 and Above - Tighten Cover Until Specified Propeller Shaft Bearing Preload Is Obtained.

IGNITION and ALTERNATOR SPECIFICATIONS
1973 MODELS
IGNITION SPECIFICATIONS

Engine Model	120	140	165	888	225-S	225	255	255 II-TRS	350
Condenser	.18-.25 MFD								
Coil	Auto-Lite Coil, Part No. 32193				(or)	Delco-Remy Coil, Part No. 26433			
Coil Max. Operating Amps.	1.1*					.9*			
Coil Primary Resistance (Ohms) Minimum	1.1					.9			
Coil Primary Resistance (Ohms) Maximum	1.5					1.2			
Coil Secondary Resistance (Ohms)	9,500-15,000					7,500-10,500			
Coil Secondary Continuity*	60-70*					53-63*			
Resistor Wire (Ohms)	1.8-2								
Spark Plug Type Spark Plug Gap Point Dwell Point Spring Tension Timing	Refer to "Tuneup Specifications"								

** Figures for C-91-25213 Magneto Analyzer Only*

ALTERNATOR SPECIFICATIONS

Identification Number	Ground	Rotation*	Field Current		Cold Output 5000 RPM	Hot Output
			Amperes	Volts		
1100576	Neg.	Counterclockwise	4.1-4.5	12	42 Amps.	37 Amps.
1102393	Neg.	Counterclockwise	4.1-4.5	12	43 Amps.	39 Amps.

** Rotation Is Dependent Upon Engine Rotation*

PROPELLER RECOMMENDATION CHART

Boat length can be used to select a propeller for initial trial. Correct propeller allows engine to turn recommended RPM and gives best performance. Because of many variables of boat design, only testing will determine best propeller. *Metric Conversion: 1" (inch) is equal to 2.54 centimeters (cm); 1' (foot) is equal to .305 meters (m).*

Model (Engine Horsepower)	Stern Drive	Aluminum Propellers Part Numbers		Dia.	Pitch	No. of Blades	Approx. Boat Length	Speed Range (MPH)
		RH Rotation	LH Rotation					
225-S Max. RPM: 3800-4200	1.50:1	B-48-36008A4	N.A.	14½"	25"	3 Blade Alum.	Dual, Fast	52-62
		B-48-58426A4		15"	23"	3 Blade Alum.	Up to 17'	48-57
		B-48-58424A4		15¼"	21"	3 Blade Alum.	17'-19'	45-52
		B-48-58422A4		15½"	19"	3 Blade Alum.	19'-21'	40-46
		B-48-36016A4		15¾"	17"	3 Blade Alum.	20'-25'	35-42
		B-48-36018A4		16"	15"	3 Blade Alum.	22'-27'	28-37
		B-48-36020A4		16"	13"	3 Blade Alum.	26'-32'	19-30
		B-48-36022A4		16"	11"	3 Blade Alum.	HB/WB	1-21
255 II-TRS RPM: 3800-4200	1.33:1	B-48-66448A4	B-48-66139A4	14¼"	27"	3 Blade Alum.	Dual, Fast	62-71
		B-48-65480A4	B-48-66141A4	14½"	25"	3 Blade Alum.	Up to 17'	58-66
		B-48-58426A4	B-48-66143A4	15"	23"	3 Blade Alum.	17'-19'	54-62
		B-48-65992A4	B-48-66145A4	15¼"	21"	3 Blade Alum.	19'-21'	50-57
		B-48-66432A4	B-48-66147A4	15¼"	19"	3 Blade Alum.	20'-25'	45-52

HB = Houseboat *WB = Work Boat*

BEARING PRELOAD TORQUES
MERCRUISER II-TRS

NOTE: Chart Is Set Up for NEW Bearings Only. For Old Bearings, Use Approximately 40% of These Values.

Bearing Preload Torque	Specifications
Upper Drive Shaft Only (Located in Drive Shaft Housing)	10-20 In. Lbs. (11.5-23 kg-cm)
Drive Shaft Housing Complete (Upper Drive Shaft and Universal Joint Shaft Recorded at Upper Drive Shaft)	Upper Drive Shaft Torque Plus 5-20 In. Lbs. (6-23 kg-cm)
Propeller Shaft - Taken at Propeller Shaft	Right Hand Rotation: 13-17 In. Lbs. (15-20 kg-cm) Left Hand Rotation: 13-17 In. Lbs.
Drive Unit Overall Preload (Recorded from Propeller Shaft: Refer to "Explanation of Preload", Following.)	Drive Shaft Housing Complete Preload Torque, Plus Propeller Shaft Bearing Preload Torque, Plus 2-6 In. Lbs. (2-7 kg-cm)

EXPLANATION of PRELOAD
MERCRUISER II-TRS

Before lower drive shaft (located in gear housing) bearing preload torque is measured, determine combined drive shaft and propeller shaft bearing preload. Drive shaft housing complete bearing preload is measured at upper drive shaft coupling spline, as illustrated in "Drive Shaft Housing Reassembly", Section 6. Gear housing complete bearing preload is measured at the prop shaft, as illustrated in "Gear Housing Reassembly", Section 6.

Note that, although the lower drive shaft is in place in the housing, it does not add any preload until the housings are mated together. Drive unit overall preload torque (as measured at the prop shaft) is to be 2-6 in. lbs. (2-7kg-cm) greater than the sum of the previously measured drive shaft and gear housing preload torques, as illustrated in "Gear Housing Installation", Section 6.

EXAMPLE:

Assume that the slotted nut on upper drive shaft was tightened until shaft measured 15 in. lbs. (17kg-cm) of bearing preload torque. Universal joint shaft then is positioned in drive shaft housing according to reassembly instructions in Section 6.

Preload is set by shims under back cover and is adjusted until entire drive shaft housing over-all preload is 5 to 20 in. lbs. (6 to 23kg-cm) above upper drive shaft bearing preload torque, which was 15 in. lbs., for a total of 20 to 35 in. lbs. (23 to 40kg-cm).

Assume the measured value of over-all drive shaft housing preload to be 27. in. lbs. (31kg-cm). Now gear housing propeller shaft preload is measured (following reassembly procedures in Section 6) and is found to be 15 in. lbs. The housings are then bolted together (following recommended procedure in Section 6) for shimming lower drive shaft bearing preload. The sum of drive shaft housing and gear housing propeller shaft bearing preload torque is 42 in. lbs. (48kg-cm); therefore, over-all preload (as measured at propeller shaft) should be 2 to 6 in. lbs. (2 to 7kg-cm) above combined drive shaft housing and propeller shaft preloads -- or between 44 to 48 in. lbs. (51 to 55kg-cm). This is illustrated by shaded area in the preload chart, following.

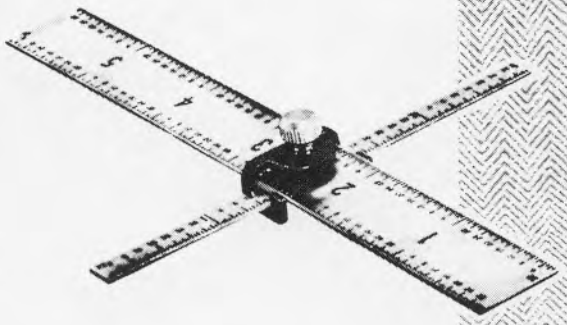
If over-all preload (as measured) is above chart limit (48 in. lbs. for this example), bearings might not be seated. Turn propeller shaft several times, then recheck over-all torque. If still out of specifications, housings MUST be split and rechecked.

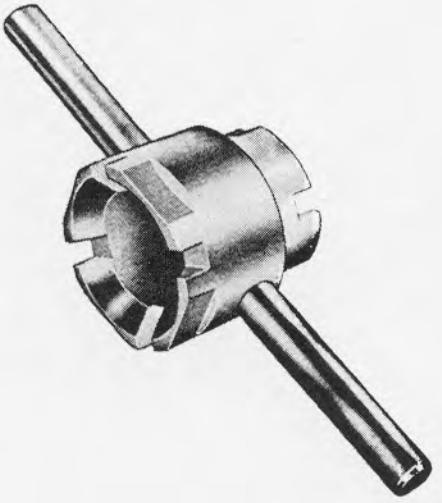
OVERALL TORQUES at PROPSHAFT
MERCRUISER II-TRS COMPLETE DRIVE UNIT

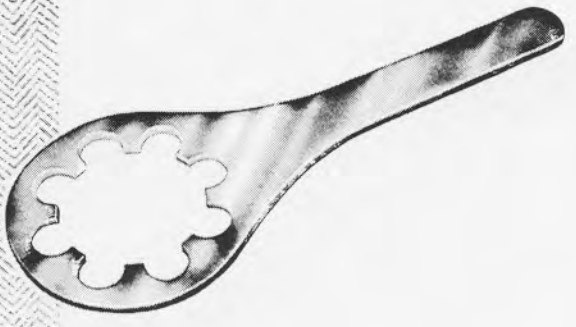
PROPSHAFT TORQUE ONLY (as MEASURED)	DRIVE SHAFT HOUSING (COMPLETE) TORQUE (as MEASURED at UPPER DRIVE SHAFT)																									
	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
13	30/34	31/35	32/36	33/37	34/38	35/39	36/40	37/41	38/42	39/43	40/44	41/45	42/46	43/47	44/48	45/49	46/50	47/51	48/52	49/53	50/54	51/55	52/56	53/57	54/58	55/59
14	31/35	32/36	33/37	34/38	35/39	36/40	37/41	38/42	39/43	40/44	41/45	42/46	43/47	44/48	45/49	46/50	47/51	48/52	49/53	50/54	51/55	52/56	53/57	54/58	55/59	56/60
15	32/36	33/37	34/38	35/39	36/40	37/41	38/42	39/43	40/44	41/45	42/46	43/47	44/48	45/49	46/50	47/51	48/52	49/53	50/54	51/55	52/56	53/57	54/58	55/59	56/60	57/61
16	33/37	34/38	35/39	36/40	37/41	38/42	39/43	40/44	41/45	42/46	43/47	44/48	45/49	46/50	47/51	48/52	49/53	50/54	51/55	52/56	53/57	54/58	55/59	56/60	57/61	58/62
17	34/38	35/39	36/40	37/41	38/42	39/43	40/44	41/45	42/46	43/47	44/48	45/49	46/50	47/51	48/52	49/53	50/54	51/55	52/56	53/57	54/58	55/59	56/60	57/61	58/62	59/63

NOTE: Chart Is Set Up for NEW Bearings Only. For Old Bearings, Use Approximately 40% of These Values.

MERCRUISER
SECTION 9







TOOLS

SECTION 9 - TOOLS

MERCRUISER

MERCURY MARINE

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SPECIAL SERVICE TOOLS

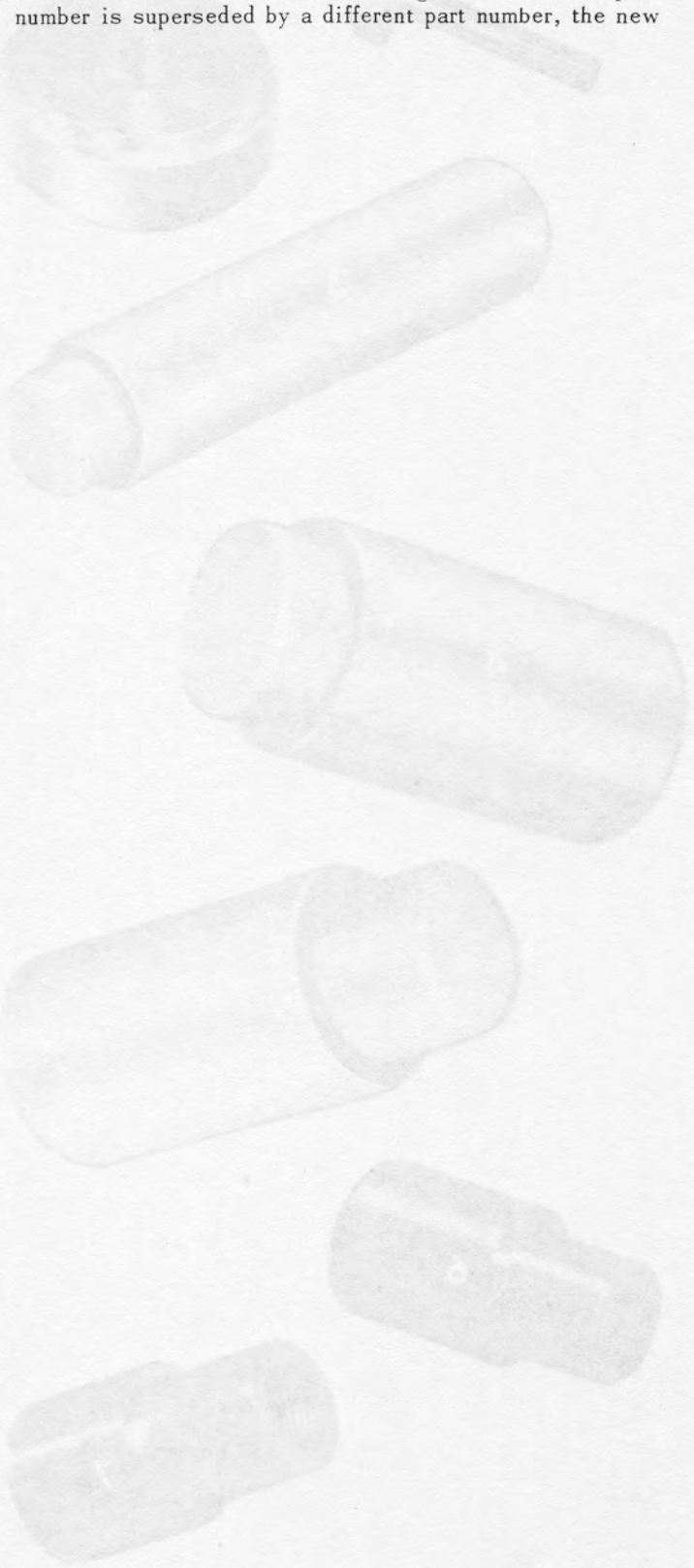
This section is divided into stern drive tools, MerCruiser engine tools and general MerCruiser tools.

Tools are listed within each model group by part number and in numerical order, starting with the lowest number.

Tools marked "(NLA)" are No Longer Available. If part number is superseded by a different part number, the new part number will follow the description.

Symbol (*), following part number, indicates tool is also used on Mercury Outboards. Refer to Tool Section of Mercury Outboard Master Service Manual for outboard application.

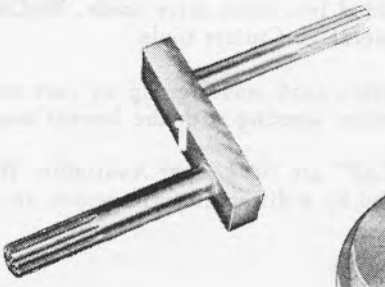
Tool figures are shown for reference and identification.



MERCRUISER 60-80-90 STERN DRIVE UNIT

1. C-91-25821A1* - STAND

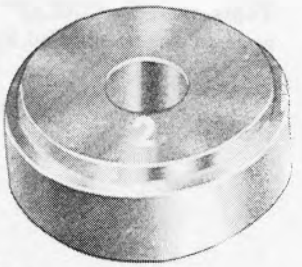
Holds upper drive shaft assembly when removing and installing impeller shaft.

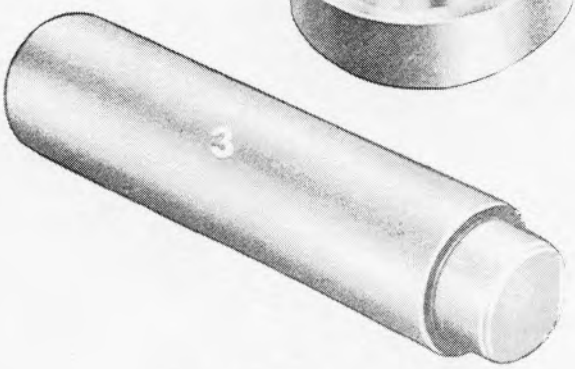


2. C-91-31361* - DRIVER, BEARING CUP

For installing tapered roller bearing cup in gear housing.

(Also under MerCruiser II)





3. C-91-33489 - DRIVER, NEEDLE BEARING 4½"
(11.430cm)

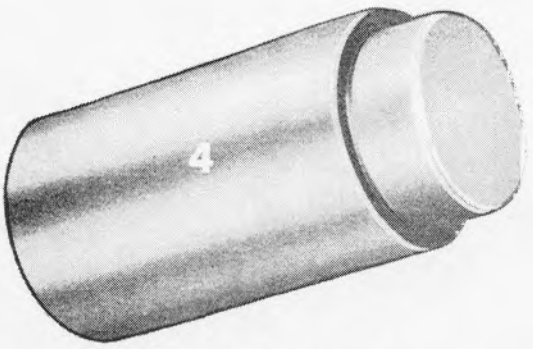
For installing small upper steering shaft needle bearing in gimbal housing.

(Also under MerCruiser I)

4. C-91-33491 - DRIVER, NEEDLE BEARING 2½"
(6.350cm)

For removing and installing large upper steering shaft needle bearing in gimbal housing.

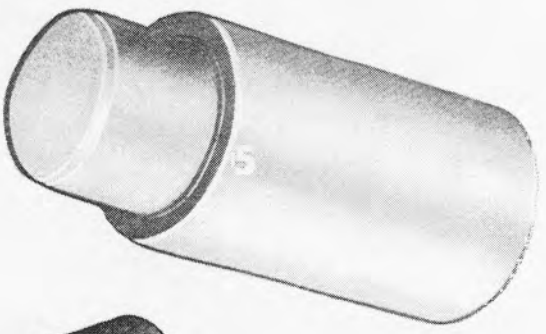
(Also under MerCruiser I)



5. C-91-33492 - DRIVER, NEEDLE BEARING 2-5/8"
(6.668cm)

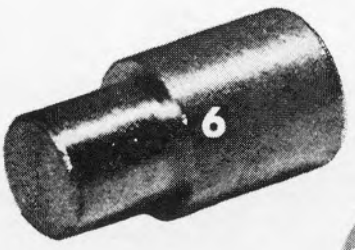
For removing and installing lower swivel pin needle bearing in gimbal ring.

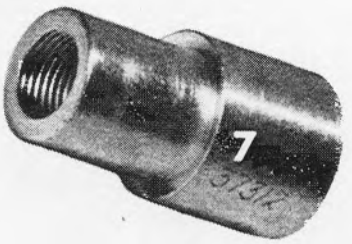
(Also under MerCruiser I)



6. C-91-37311* - DRIVER HEAD

Used with Driver Rod C-91-37323 to remove and install bearing carrier oil seals and roller bearing.



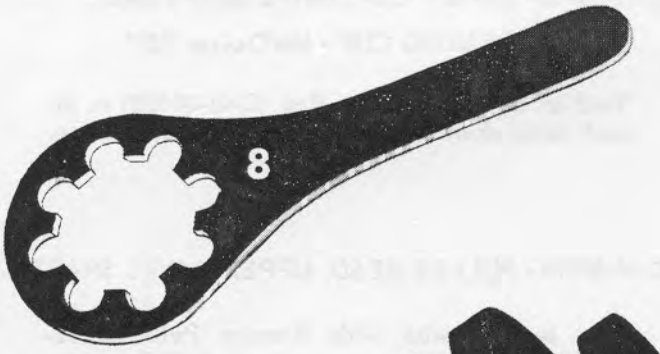


7. C-91-37312* - DRIVER HEAD

Used with Driver Rod (C-91-37323) to remove and install drive shaft bearing in gear housing.

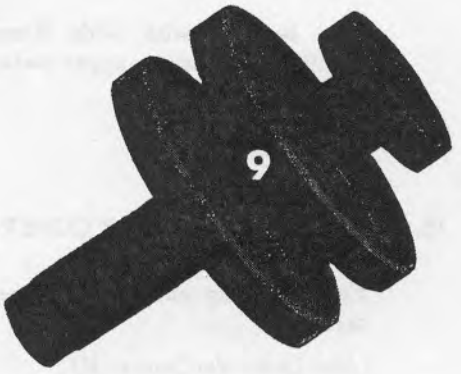
8. C-91-38378 - UNIVERSAL JOINT BEARING COVER WRENCH

Tool is required for removing and installing universal joint bearing cover.



9. C-91-38763 - SHIMMING TOOL, UPPER DRIVE GEAR

Determines correct shim thickness between drive shaft housing and universal joint roller bearing so that drive gear will mesh correctly with pinion gear.



10. C-91-38764 - SHIMMING TOOL, UPPER PINION

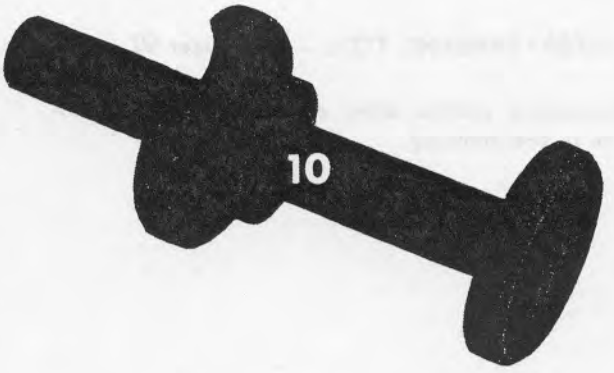
Tool is required for determining correct shim thickness between drive shaft housing and roller bearing cup so that pinion gear will mesh correctly with drive gear.

11. C-91-38788A2 - TRANSOM DRILL FIXTURE KIT - (NLA) MerCruiser 60-80

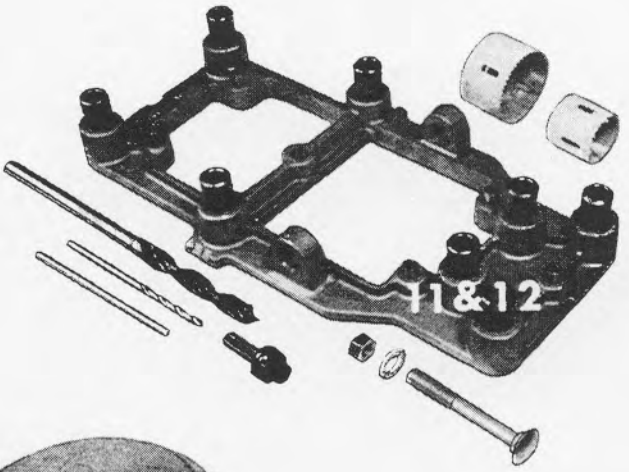
12. C-91-38788A3 - TRANSOM DRILL FIXTURE KIT - MerCruiser 90

Drilling Kit provides a simple means of locating and drilling the mounting holes and the necessary transom cutout to install the MerCruiser "O" Stern Drive Unit.

NOTE: Do not order individual tools if C-91-38788A3 is ordered.

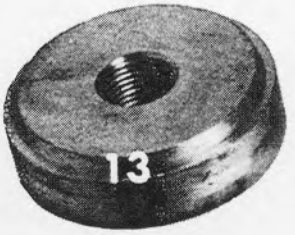


(NLA) C-91-32926 Drill Guides - 9/16"
(NLA) C-91-32927 Drill Guides - 1/4"
C-91-38789 Hole Saw - 2-5/8" Dia.
(NLA) C-91-32928 Hole Saw - 1-3/4" Dia.
(NLA) C-91-32929 Hole Saw Arbor
(NLA) C-91-33377 Wood Extension Drill - 9/16" Dia .x 12" Long with 1/2" Dia .Shank
C-91-33378 Aircraft Extension Drill - 1/4" Dia. x 6" Long 118 Split Point
(NLA) C-91-32932 Guide Rod - Hole Saw
C-10-35624 Bolt, Carriage - 1/2-13x4
C-12-21900 Washer - 17/32x1x3/32 Plain
C-11-38790 Nut - 1/2 - 13 Hex



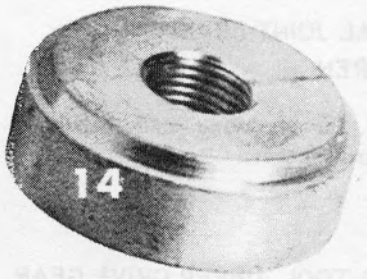
13. C-91-38917 - DRIVER CUP, UPPER DRIVE SHAFT BEARING CUP

Tool is used with the Driver Rod (C-91-37323) to install upper drive shaft bearing cup in drive shaft housing.



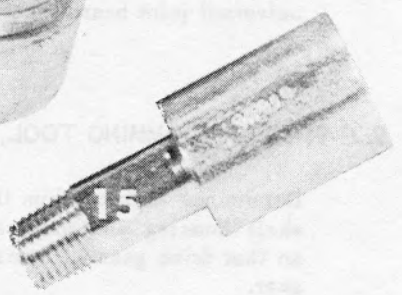
14. C-91-38918 - DRIVER CUP, DRIVE SHAFT BALL BEARING CUP - MerCruiser "O"

Tool is used with Driver Rod (C-91-37323) to install drive shaft ball bearing cup in gear housing.



15. C-91-38919 - PULLER HEAD, UPPER SWIVEL SHAFT

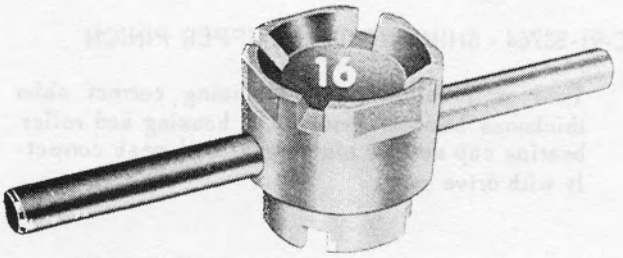
Tool is used with Slide Hammer Puller (C-91-34569A1) to remove upper swivel shaft from gimbal ring.



16. C-91-53126* - GEAR CASE COVER RETAINER TOOL

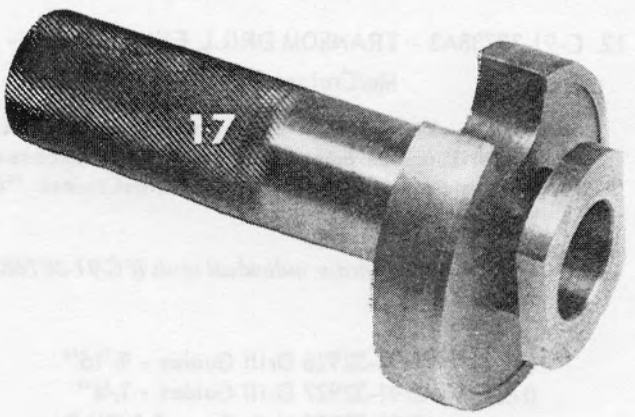
For installing and removing gear case cover retainer.

(Also under MerCruiser II)



17. C-91-56050 - SHIMMING TOOL - MerCruiser 90

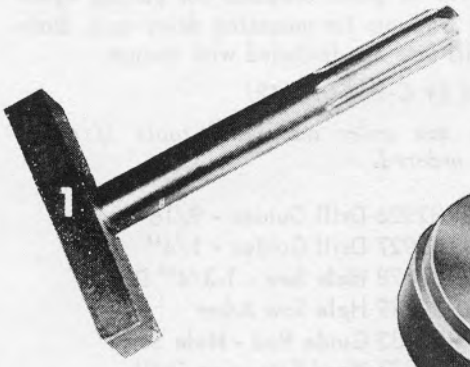
Determines correct drive shaft pinion gear position in gear housing.

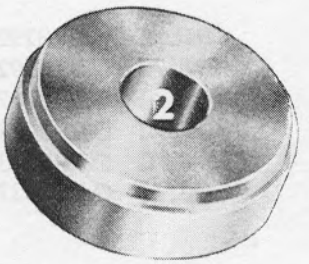


MERCRUISER I TYPE

1. C-91-30591A1* - POWERHEAD STAND

For holding upper drive shaft while loosening or tightening roller bearing retaining nut.

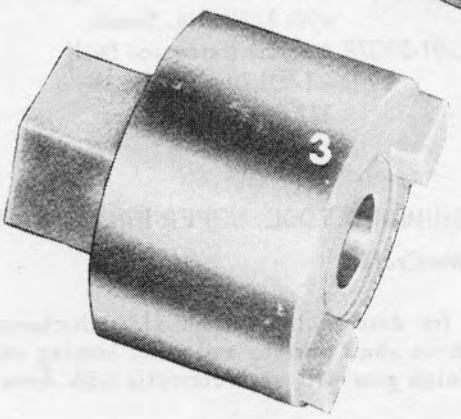




2. C-91-31106* - DRIVER, BEARING CUP- MerCruiser I

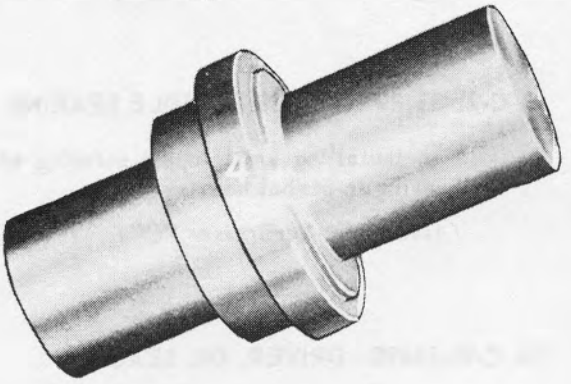
For installing forward gear bearing cup in gear housing.

(Also under MerCruiser II).



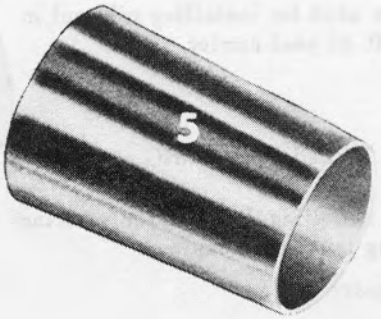
3. C-91-31107* - SHIFT SHAFT TOOL

Removes and installs shift shaft bushing.



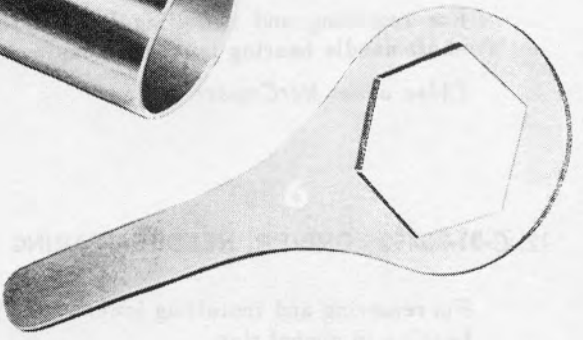
4. C-91-31108* - DRIVER, OIL SEAL

For installing propeller shaft oil seals in bearing carrier.



5. C-91-32699* - SLEEVE, OIL SEAL INSTALLING

Prevents damage to propeller shaft oil seals when installing bearing carrier in gear housing.



6. C-91-32822 - WRENCH, THREADED COVER

For removing and installing universal joint bearing cartridge cover.

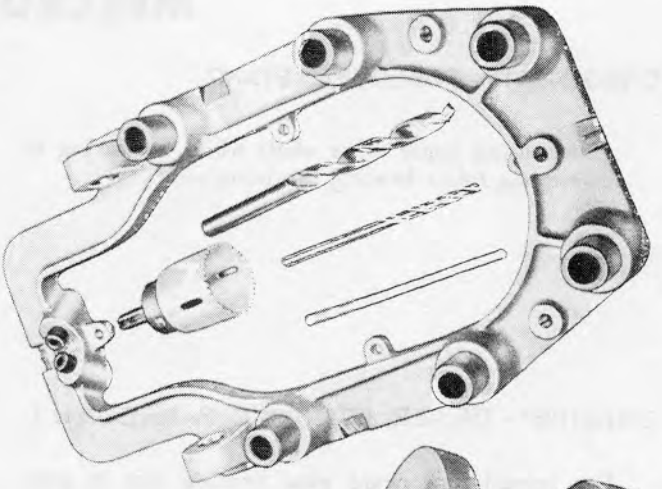
7. C-91-32924A2 - TRANSOM DRILLING FIXTURE

Used in place of paper template for cutting opening in boat transom for mounting drive unit. Hole saw and drill bits are included with fixture.

(Superseded by C-91-56187A2)

NOTE: Do not order individual tools if C-91-32924A2 is ordered.

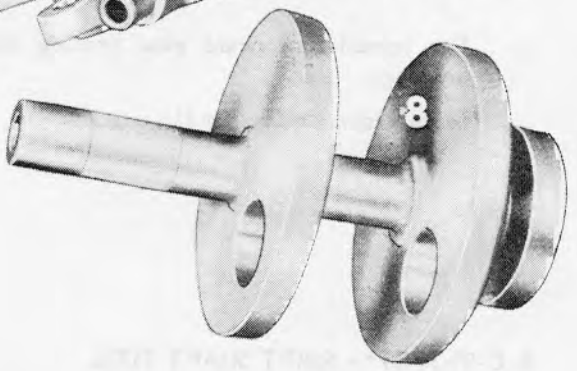
(NLA) C-91-32926 Drill Guides - 9/16"
(NLA) C-91-32927 Drill Guides - 1/4"
(NLA) C-91-32928 Hole Saw - 1-3/4" Dia.
(NLA) C-91-32929 Hole Saw Arbor
(NLA) C-91-32932 Guide Rod - Hole Saw
(NLA) C-91-33377 Wood Extension Drill - 9/16" Dia. x 12" Long with 1/2" Dia. Shank
C-91-33378 Aircraft Extension Drill - 1/4" Dia. x 6" Long - 118 Split Point



8. C-91-33488 - SHIMMING TOOL, UPPER PINION GEAR

MerCruiser I

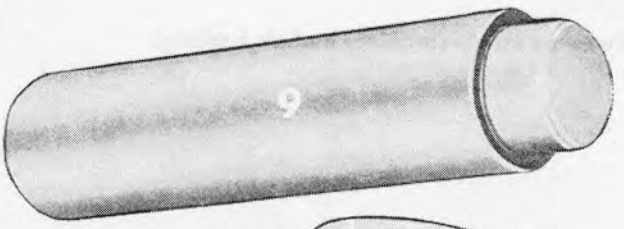
Required for determining correct shim thickness between drive shaft housing and roller bearing cup so that pinion gear will mesh correctly with drive gear.



9. C-91-33489 - DRIVER, NEEDLE BEARING

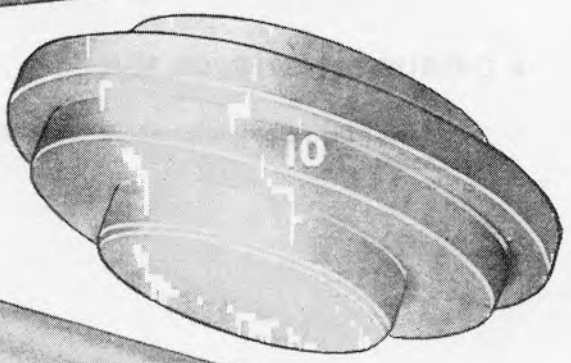
For installing small upper steering shaft needle bearing in gimbal housing.

(Also under MerCruiser "O")



10. C-91-33490 - DRIVER, OIL SEAL

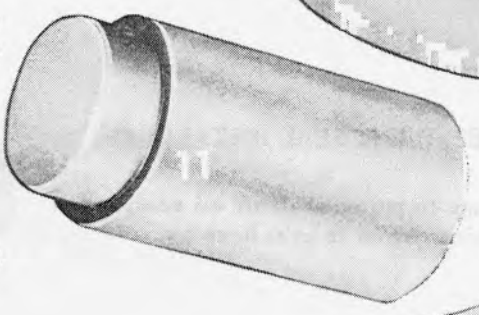
For installing upper drive shaft oil seal in drive shaft housing. Also used for installing oil seal in universal joint shaft oil seal carrier.



11. C-91-33491 - DRIVER, NEEDLE BEARING

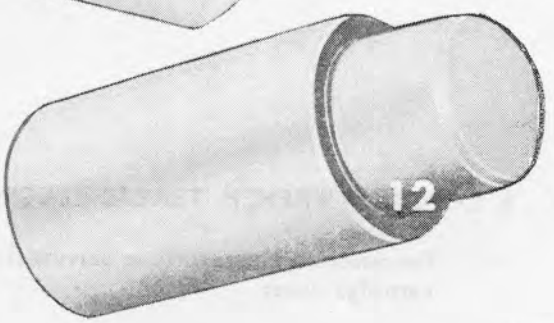
For removing and installing large upper steering shaft needle bearing in gimbal housing.

(Also under MerCruiser "O")



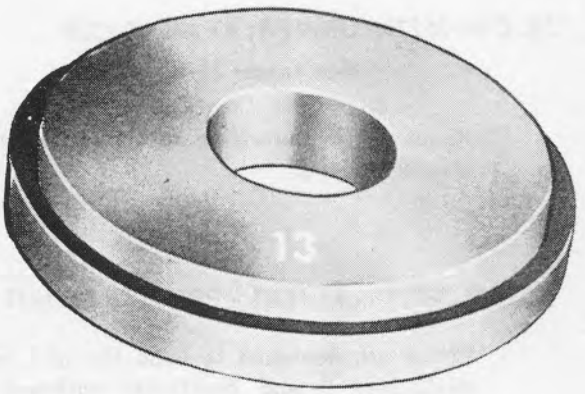
12. C-91-33492 - DRIVER, NEEDLE BEARING

For removing and installing lower swivel pin needle bearing in gimbal ring.



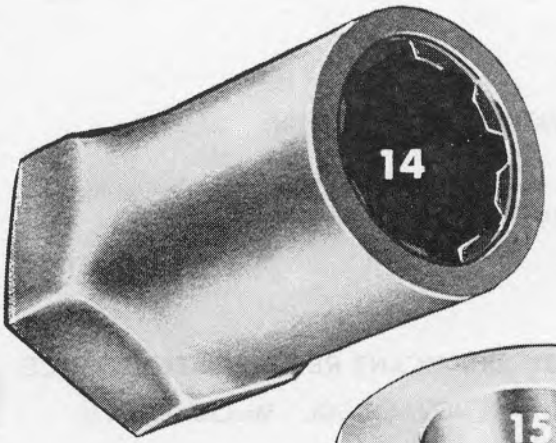
13. C-91-33493 - DRIVE BEARING CUP
MerCruiser IA-IB-IC

For installing upper drive shaft lower roller bearing cup in drive shaft housing.



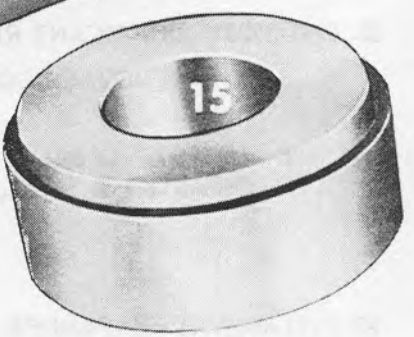
14. C-91-34377A1 - WRENCH, DRIVE SHAFT NUT
MerCruiser 1

For removing and installing drive shaft tapered roller bearing retaining nut.



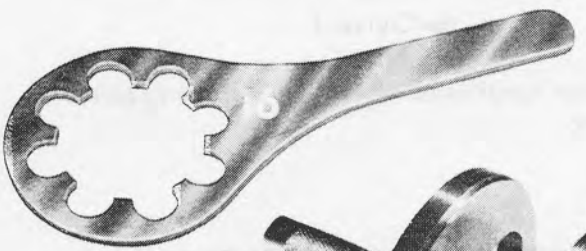
15. C-91-34379 - DRIVER, BEARING CUP
MerCruiser I & IA-IB-IC

For installing drive shaft tapered roller bearing ing cup in gear housing.



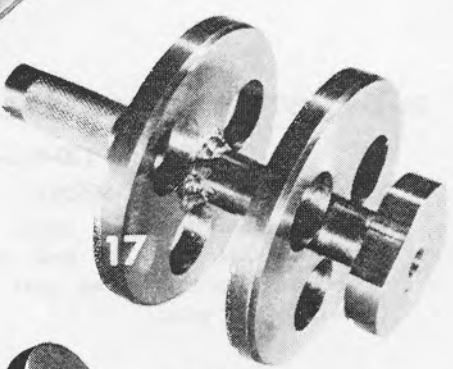
16. C-91-36235 - BEARING RETAINER WRENCH
MerCruiser IA-IB-IC

Bearing Retainer Wrench required for removing the threaded cover on drive shaft housings.



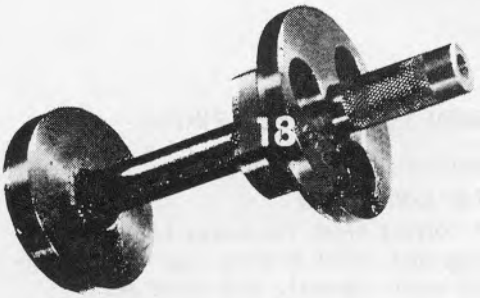
17. C-91-36384 - SHIMMING TOOL UPPER PINION GEAR
MerCruiser IA-IB-IC

For determining correct shim thickness between drive shaft housing and roller bearing cup so that pinion gear will mesh correctly with drive gear.



18. C-91-36385 - SHIMMING TOOL, DRIVE GEAR

Required for determining correct shim thickness between drive shaft housing and universal joint roller bearing so that drive gear will mesh correctly with pinion gear.



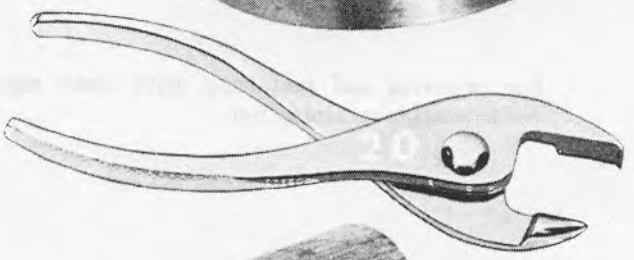
19. C-91-36577 - DRIVER, BEARING CUP

MerCruiser IA-IB-IC

Required for installing forward gear bearing cup in gear housing.

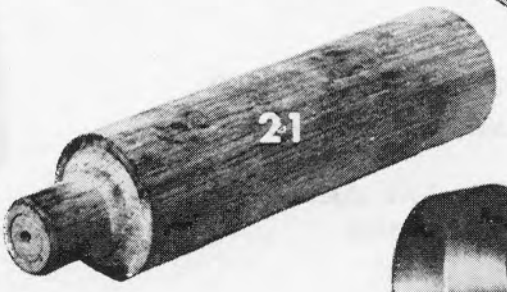
20. C-91-38277* - PLIERS - PROPELLER NUT LOCK TAB

Pliers are designed to bend the lock tabs up on MerCruiser I and 6-cylinder outboard propeller locknuts and prevent damage to the diffuser ring.



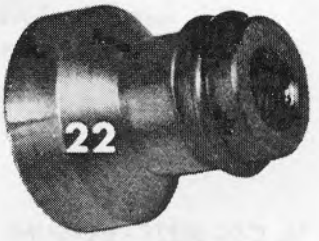
21. C-91-39238 - DRIVER, WOODEN

Tool is used for installing the recirculating device in MerCruiser I gear housing.



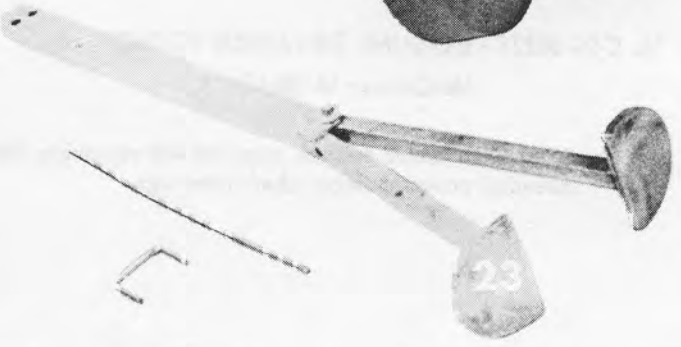
22. C-91-39281 - LUBRICANT RECIRCULATING DEVICE REMOVAL TOOL - MerCruiser I & II

Tool removes the lubricant recirculating device in MerCruiser I E-Z Shift gear housing assemblies.



23. C-91-45497A1 - EXPANDER, EXHAUST BELLOWS - MerCruiser I

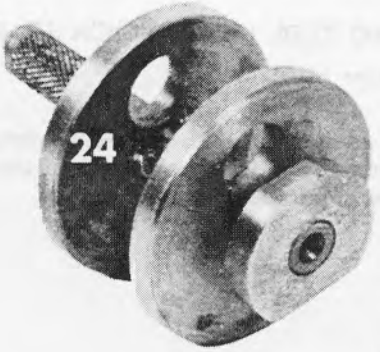
Aids installation of exhaust bellows to bell housing.



24. C-91-45877 - SHIM TOOL, UPPER DRIVE GEAR - MerCruiser 120-thru-165

(Superseded by C-91-60526)

Determines correct shim thickness between drive shaft housing and universal joint roller bearing so that drive gear will mesh correctly with pinion gear.



25. C-91-45878 - SHIM TOOL, UPPER PINION - MerCruiser 120-thru-165

(Superseded by C-91-60523)

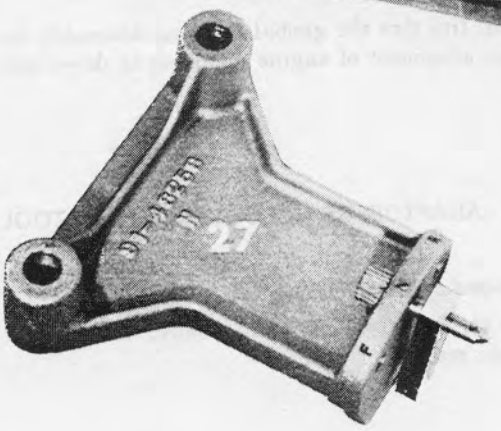
Determines correct shim thickness between drive shaft housing and roller bearing cup so that pinion gear will mesh correctly with drive gear.

26. C-91-48247 - COUPLING ALIGNING TOOL

Correctly aligns engine coupling with drive shaft universal joint.

27. C-91-48258A1 - SHIFT INDICATOR TOOL - MerCruiser I

For checking control shift cable travel and adjusting shift cables without stern drive installed.

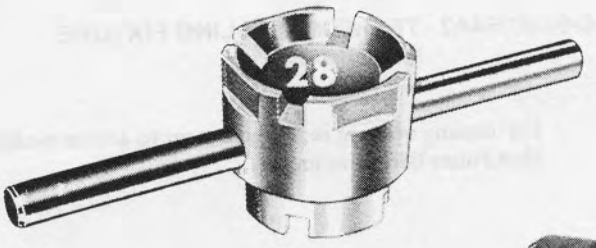


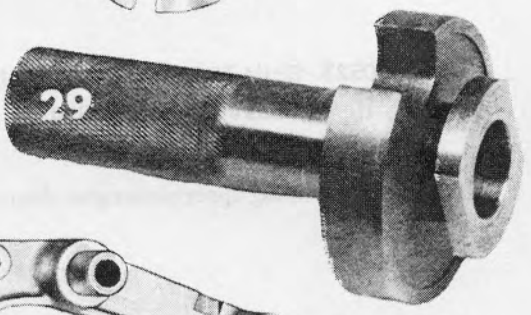
28. C-91-53126* - GEAR CASE COVER RETAINER TOOL

(Used with Adaptor C-91-59553)

For installing and removing gear case cover retainer.

(Also under MerCruiser II)

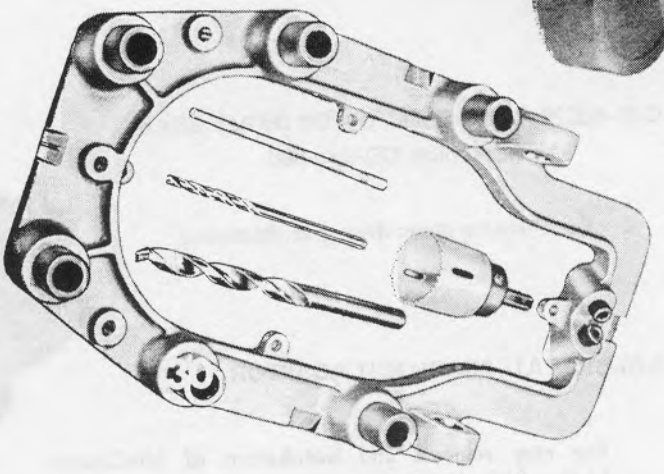




29. C-91-56048 - SHIMMING TOOL -

Late MerCruiser 120-140-165

Determines correct drive shaft pinion gear position in gear housing.



30. C-91-56187A2 - TRANSOM DRILLING FIXTURE -

MerCruiser 120-thru-165

For cutting opening in boat transom to accommodate MerCruiser 120-thru-165 drive unit.

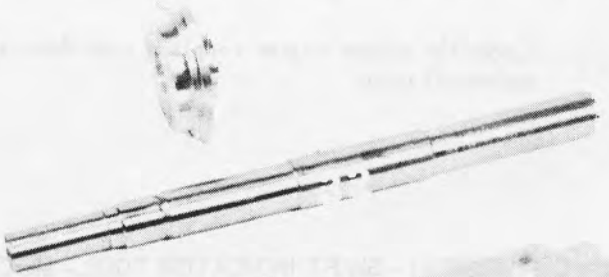
31. C-91-56775 - WRENCH, DRIVE SHAFT NUT

Aids removal of gear housing drive shaft pinion nut .

32. C-91-57797A1 - ENGINE ALIGNMENT TOOL
MerCruiser 110-thru-390

(Superseded by C-91-57797A2)

The tool fits thru the gimbal housing assembly for positive alignment of engine coupling to drive unit shaft.



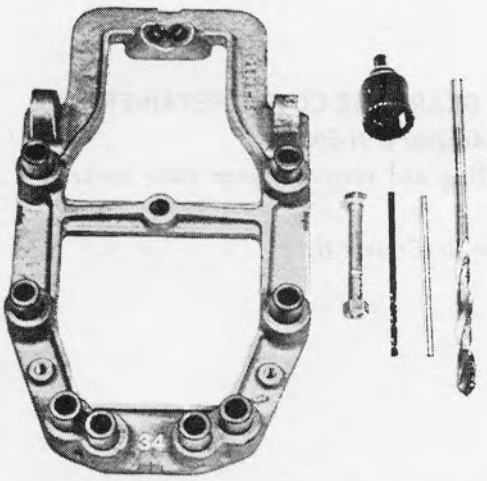
33. C-91-59553 - ADAPTOR, GEAR HOUSING COVER TOOL

(Superseded by C-91-61069)

Used with Tool C-91-53126 to remove and install gear case retainer.

34. C-91-60254A2 - TRANSOM DRILLING FIXTURE
MerCruiser 888

For cutting opening in boat transom to accommodate MerCruiser 888 drive unit.

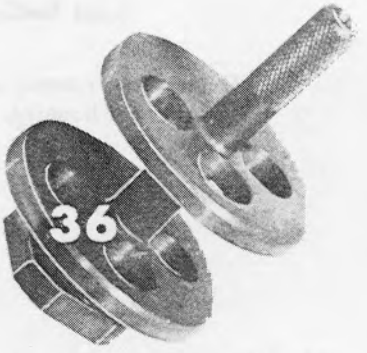


35. C-91-60523 - SHIM TOOL, UPPER PINION
MerCruiser 120-thru-888

For checking upper pinion gear shimming.

36. C-91-60526 - SHIM TOOL, UPPER DRIVE GEAR
MerCruiser 120-thru-888

For checking upper drive gear shimming.



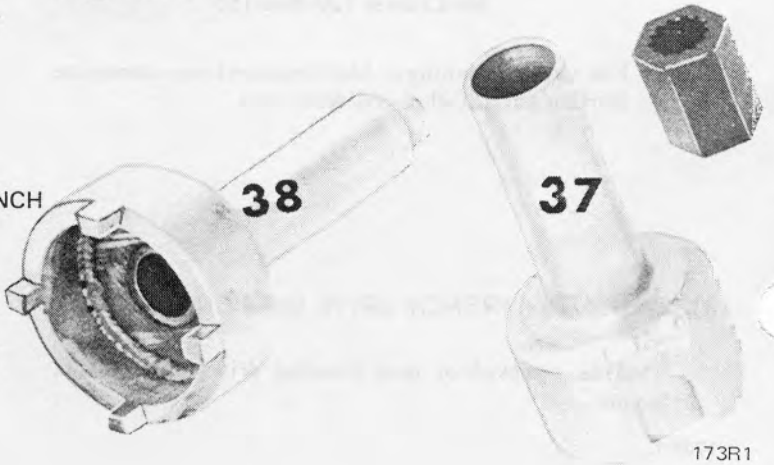
37. C-91-61067A1 - PINION NUT ADAPTOR

For easy removal and installation of MerCruiser IA-thru-888 gear housing pinion gear nut.

38. C-91-61069 - GEAR HOUSING COVER RETAINER WRENCH

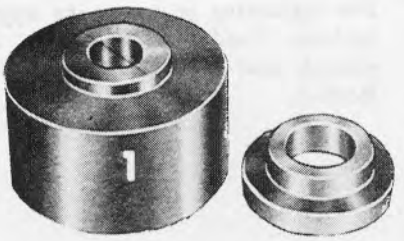
For removal and installation of MerCruiser IA-thru-888 gear housing cover.

(Used in place of Gear Housing Cover Tool C-91-53126 and Adaptor C-91-59553.)



1. C-91-26376A1* - PROPELLER SHAFT GEAR TOOL

For removing and installing propeller shaft gear.

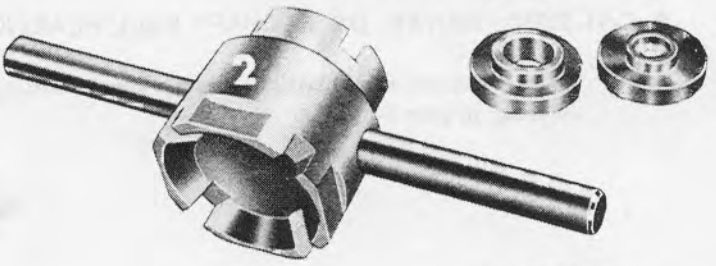


2. C-91-30291A2* - GEAR CASE COVER RETAINER TOOL

For installing and removing gear case cover retainer.

(Superseded by C-91-53126)

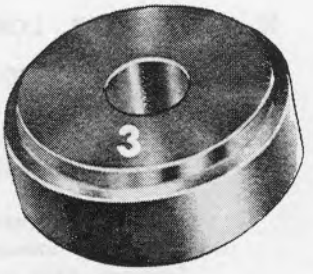
(Also under Mercruiser I)



3. C-91-31106* - DRIVER, BEARING CUP

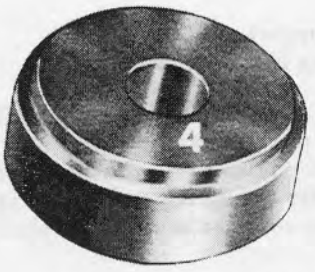
For installing tapered roller bearing cup in carrier in gear housing.

(Also under MerCruiser I)



4. C-91-31361* - DRIVER, BEARING CUP

For installing tapered roller bearing cup in gear housing.

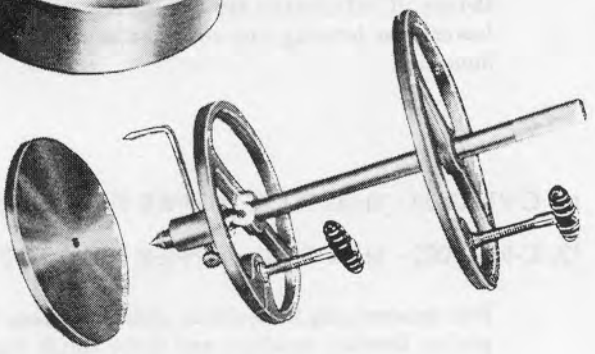


5. C-91-31620A1-A3 - ALIGNMENT TOOL

For aligning engine to drive unit when making installations.

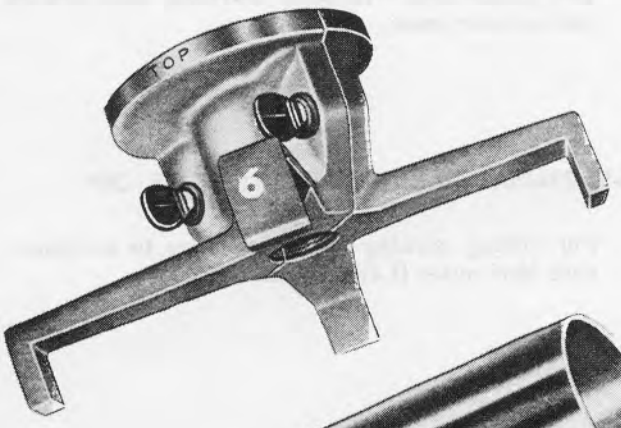
(NLA) C-91-32136 - Plate, Rear
(NLA) C-91-35627 - Plate, Front
(NLA) C-91-32142A1 - Thumb Screw
(NLA) C-91-32138 - Shaft
(NLA) C-91-32139 - Pointer
(NLA) B-10-32141 - Thumb Screw
(NLA) C-91-32135 - Disc, Adjusting

(Superseded by C-91-31620A3)



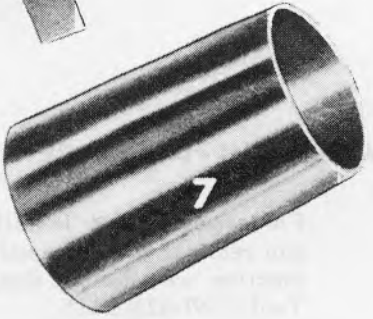
6. C-91-32295A1 - ALIGNMENT TOOL
(NLA)

For checking alignment of engine to drive unit on completed installation.



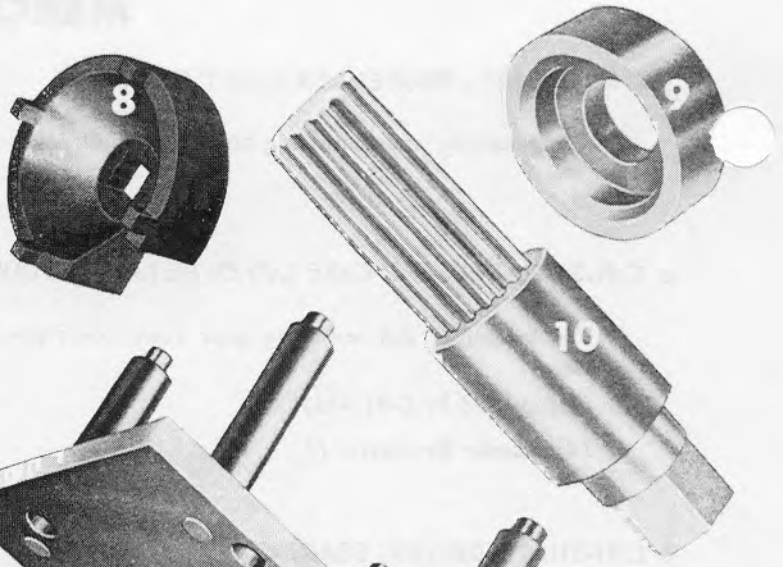
7. C-91-32326 - SLEEVE, GEAR CASE COVER INSTALLING
(NLA)

For installing gear housing cover in gear housing. Protects propeller shaft oil seal in cover when sliding oil seal over propeller shaft.



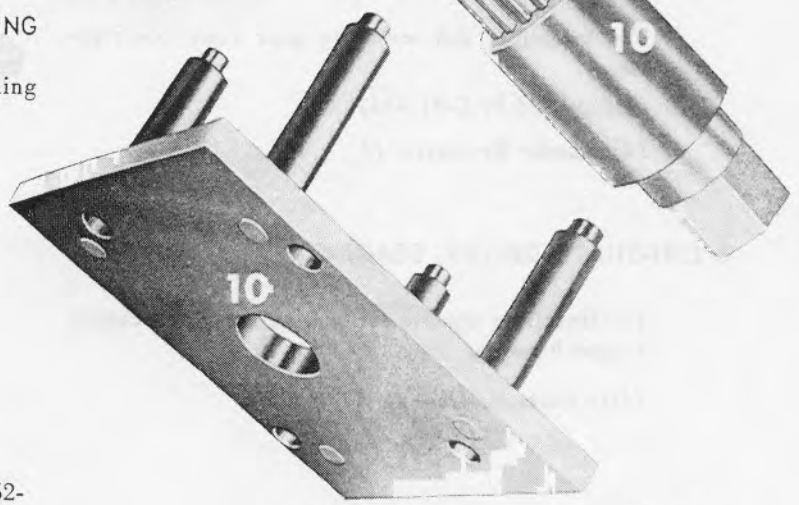
8. C-91-32329 - WRENCH, UPPER GEAR LOCKNUT

For tightening or loosening upper and lower gear locknut. Used with ½" drive, foot pound torque wrench and C-91-32328A2 Locknut Tightening Holder.



9. C-91-32330 - DRIVER, DRIVE SHAFT BALL BEARING

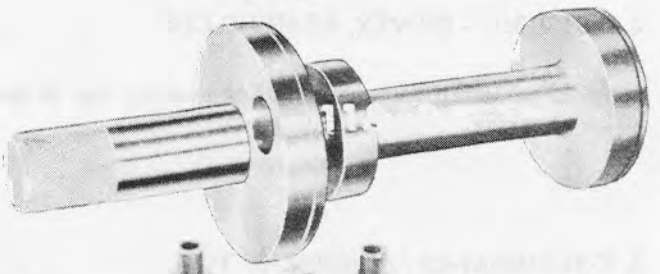
Protects drive shaft ball bearing when installing bearing in gear housing.



10. C-91-32332A3 - LOWER GEAR LOCKNUT TIGHTENING TOOL

1) - Wrench Adaptor (upper)
1) - Top Cover Holding Fixture (lower)

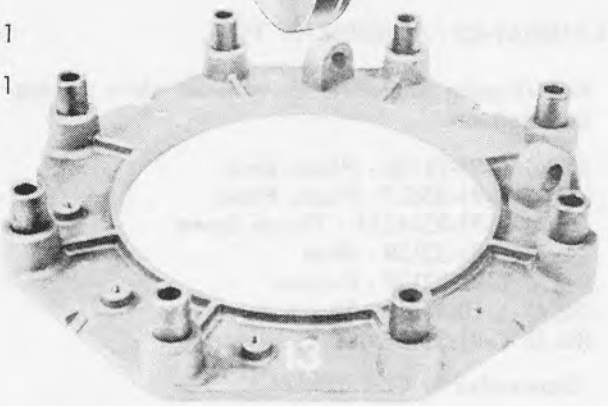
Used in conjunction with Sliding Clutch (B-52-31530 for loosening and tightening lower gear locknut. Also used in conjunction with Retainer Driver (C-91-35545) for tightening and loosening lower gear bearing cup retainer in the drive shaft housing.



11. C-91-32334 - SHIM TOOL, UPPER PINION GEAR - 1.33:1

12. C-91-52002 - SHIM TOOL, UPPER PINION GEAR - 1.78:1

For determining the correct shim thickness between pinion bearing retainer and drive shaft housing so that pinion gear will mesh correctly with forward and reverse gears.

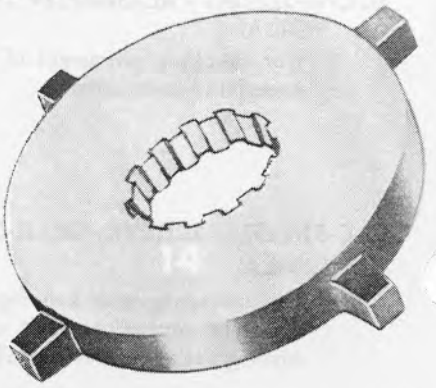


13. C-91-35449A2 - DRILLING FIXTURE, 8° - 20°

For cutting opening in boat transom to accommodate MerCruiser II drive unit.

14. C-91-35545 - DRIVER, RETAINER

For removing and installing lower gear bearing cup retainer in drive shaft housing. Used in conjunction with Lower Gear Lock Nut Tightening Tool (C-91-32332A1).



15. B-47457 - ALIGNMENT ROD -

MerCruiser 200-225 (1.78:1 Drive)

Aligns engine with inner transom plate .

16. C-91-49670 - TIGHTENING BAR -

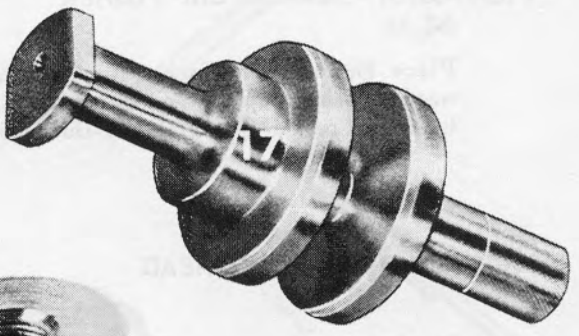
MerCruiser 200-225 (1.78:1 Drive)

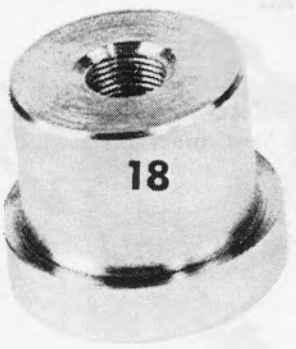
Tightens clamp nut.

17. C-91-52001 - SHIMMING TOOL, FORWARD and REVERSE GEARS -

1.33:1 and 1.78:1 DRIVE RATIO

For determining the correct shim thickness under forward and reverse gear bearings so that gears will mesh correctly with pinion gear.





18. C-91-52393 - DRIVER, NEEDLE BEARING

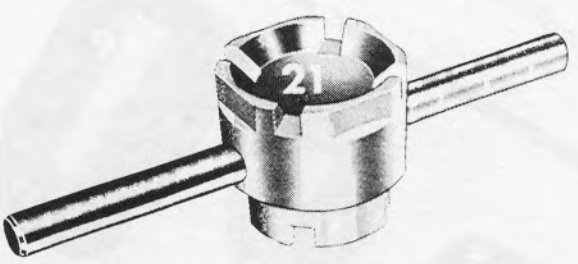
To remove gear housing drive shaft pinion bearing .

19. C-91-52394 - HEAD PULLER

To install gear housing drive shaft pinion bearing.

20. C-91-53122 - SWAGING TOOL

To secure gear assembly locknut .



21. C-91-53126* - GEAR CASE COVER RETAINER TOOL

For installing and removing gear case cover retainer.

(Also under MerCruiser 1)

22. C-91-54638 - TORQUE WRENCH ADAPTOR -

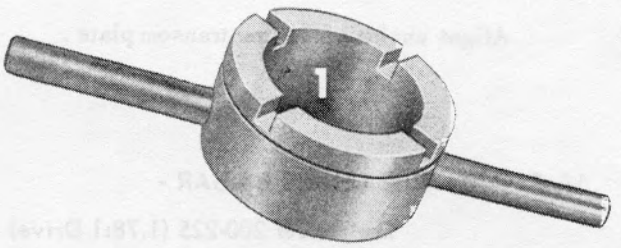
MerCruiser 200 Coupling Nut

Used to torque engine coupling nuts.

MERCRUISER II 2:1 HEAVY DUTY TOOLS

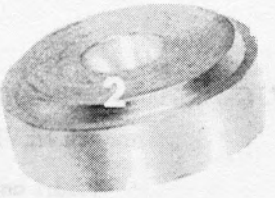
1. C-91-38457 - GEAR CASE COVER TOOL

Tool is required for removing and installing the gear housing cover of MerCruiser II 2:1 Heavy-Duty lower unit.



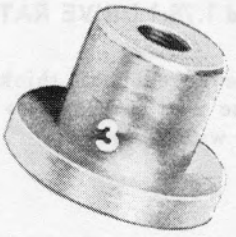
2 .C-91-38761 - BEARING CUP PUSHER (NLA)

Place Bearing Cup Pusher in propeller shaft forward bearing cup and press or tap bearing cup into MerCruiser II 2:1 Heavy-Duty gear housing.



3. C-91-38762 - PULL ROD HEAD

Used in conjunction with Bearing Removal and Installation Kit (C-91-31229A4) for installing drive shaft roller bearing into MerCruiser II 2:1 Heavy-Duty gear housing.



MERCRUISER III STERN DRIVE UNIT

1. C-91-31229A4 - PULLER ROD ASSEMBLY

For bearing removal and installation.

2. C-91-33493 - DRIVER CUP

For bearing removal and installation.

3. C-91-34569A1 - SLIDE HAMMER PULLER

For removing all tapered roller bearing cups. Will fit other applications as well.

C-91-34570 - Jaws - Replacement, Slide Hammer Puller

4. C-91-37241 - UNIVERSAL PULLER PLATE

For pulling gears and bearings. The "knife-like" edges of puller plates may be forced behind the part. The finest alloy steels and expert heat treating assures unequaled strength. This plate supersedes previous puller plates.

5. C-91-37323 - DRIVER ROD

For bearing removal and installation.

6. C-91-38762 - PULLER HEAD

For bearing removal and installation.

7. B-47457 - ALIGNMENT ROD - MerCruiser 200-225-250

(Use tool C-91-57797A3)

8. B-47458 - ALIGNMENT ROD - MerCruiser 325-390

(NLA - Use tool C-91-57797A3)

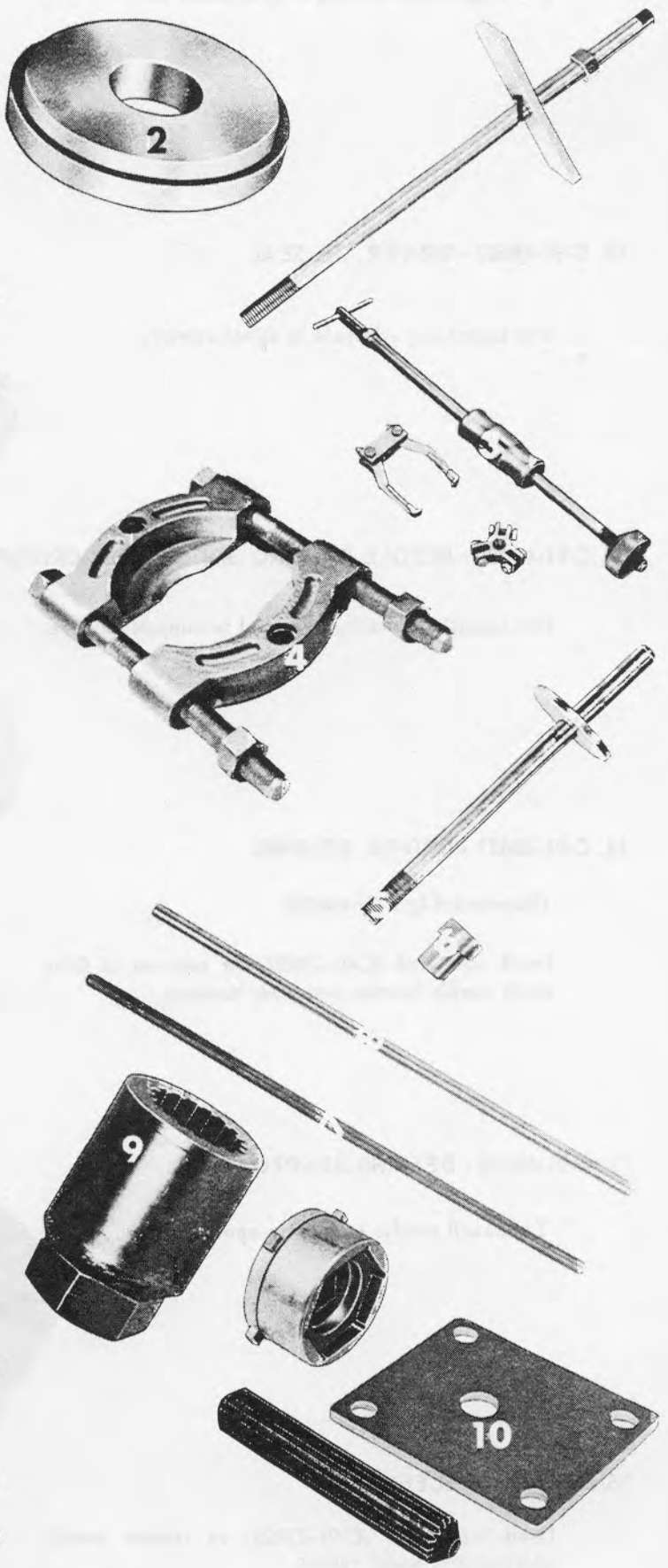
For aligning engine to drive unit when making installations.

9. C-91-48606 - TORQUING TOOL

For torquing gear case pinion and bearing assembly nuts.

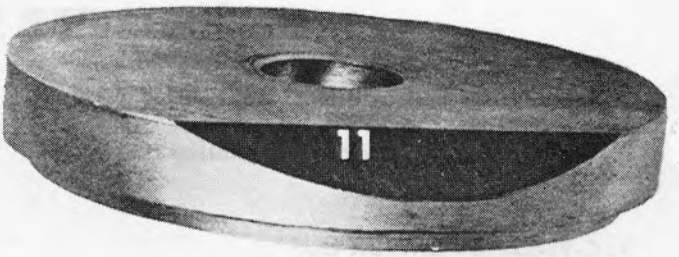
10. C-91-48614A1 - GEAR NUT and RETAINER WRENCH

For removing and torquing nut and retainer in drive shaft housing.



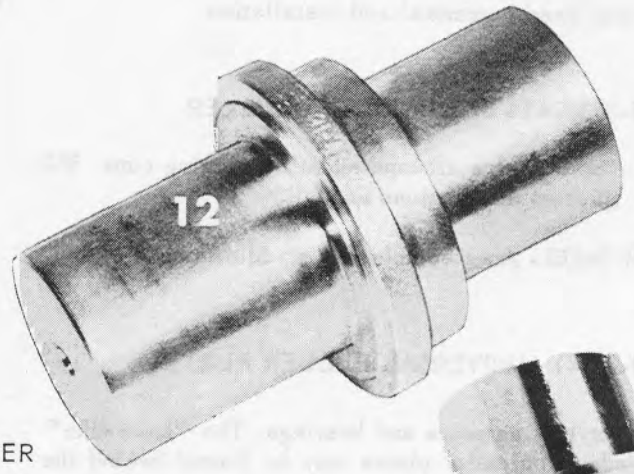
11. C-91-48619 - DRIVER CUP

For large roller bearing in gear housing.



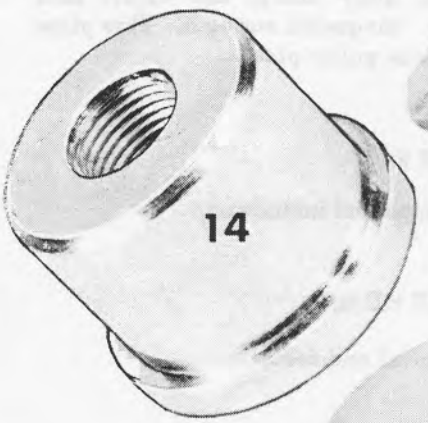
12. C-91-48622 - DRIVER, OIL SEAL

For installing oil seals in spool carrier.



13. C-91-48630 - NEEDLE BEARING and OIL SEAL DRIVER

For installing bearing and seal in support housing.



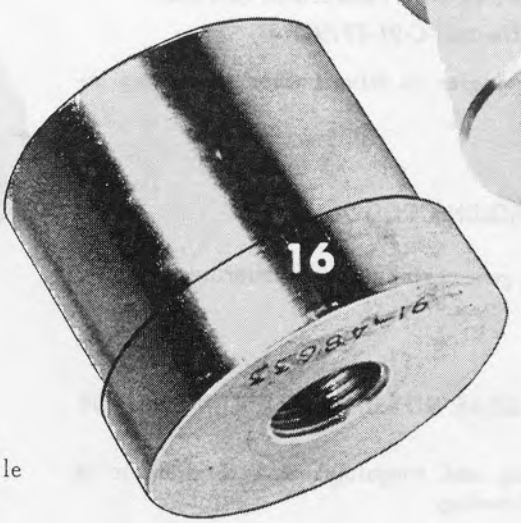
14. C-91-48631 - DRIVER, BEARING

(Superseded by C-91-63638)

Used with Rod (C-91-37323) for removal of drive shaft needle bearing from gear housing.

15. C-91-48632 - BEARING ADAPTOR

To install needle bearing in spool carrier.

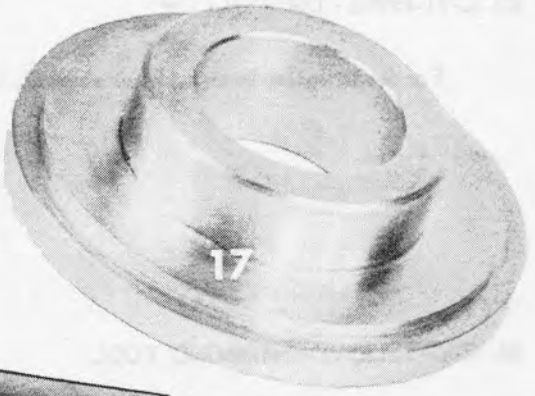


16. C-91-48633 - SLEEVE

Used with Rod (C-91-37323) to remove needle bearing from spool carrier.

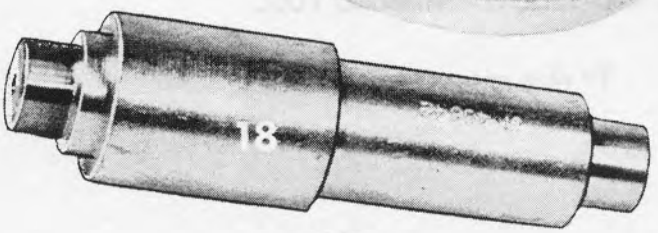
17. C-91-48635 - DRIVER, OIL SEAL

For installing oil seal in drive shaft housing.



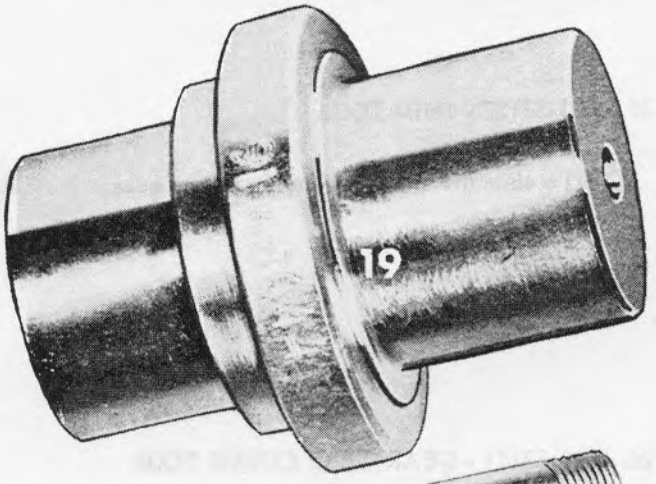
18. C-91-48642 - DRIVER, NEEDLE BEARING and OIL SEAL

For removing bearing and seals in gimbal housing.



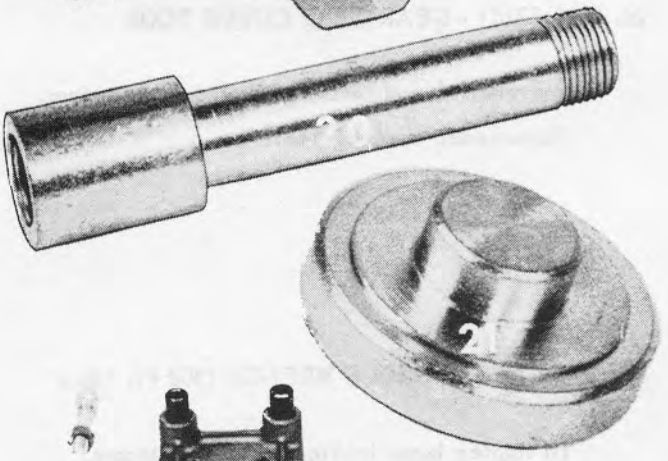
19. C-91-48644 - DRIVER, NEEDLE BEARING and OIL SEAL

For installing bearing and lower oil seal in gimbal housing.



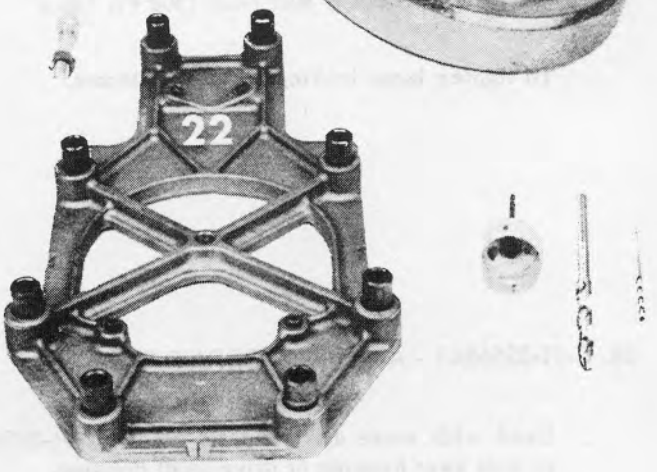
20. C-91-48653 - PULLER

Used with Slide Hammer (C-91-34569A1) to remove upper swivel shaft from gimbal housing.



21. C-91-48663 - DRIVER, OIL SEAL

For installing oil seal in drive shaft housing front cover.

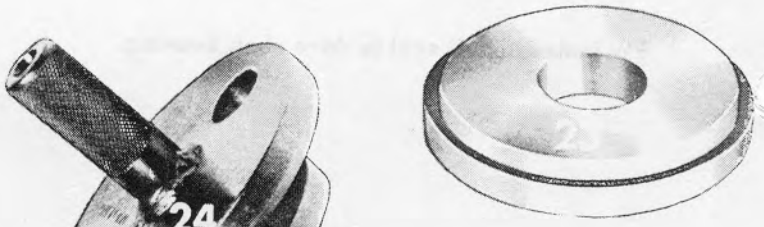


22. C-91-48703A2 - TRANSOM CUTOUT and DRILLING KIT

For locating and drilling mounting holes and necessary transom cutout to install stern drive unit.

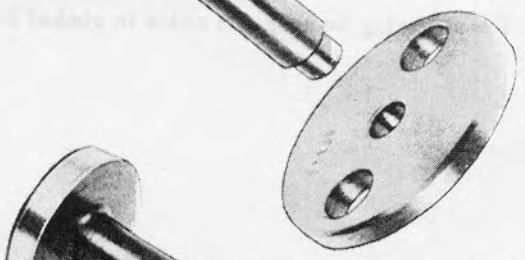
23. C-91-49994 - DRIVER CUP

For large roller bearing in drive shaft housing.



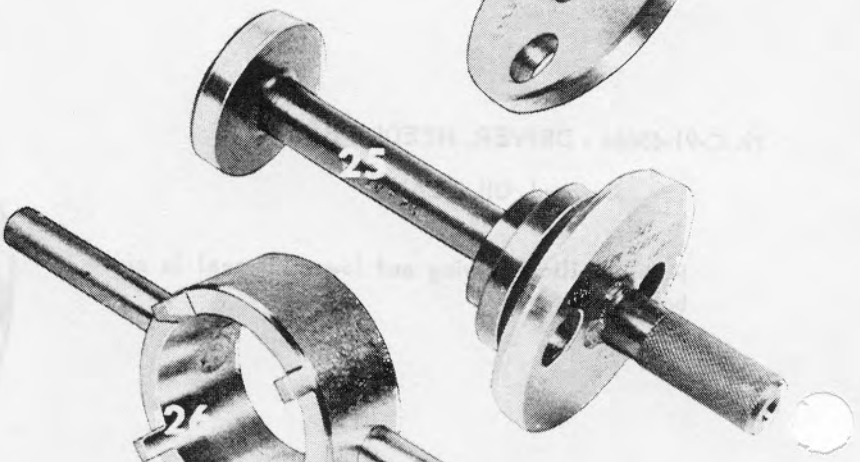
24. C-91-52135A1 - SHIMMING TOOL

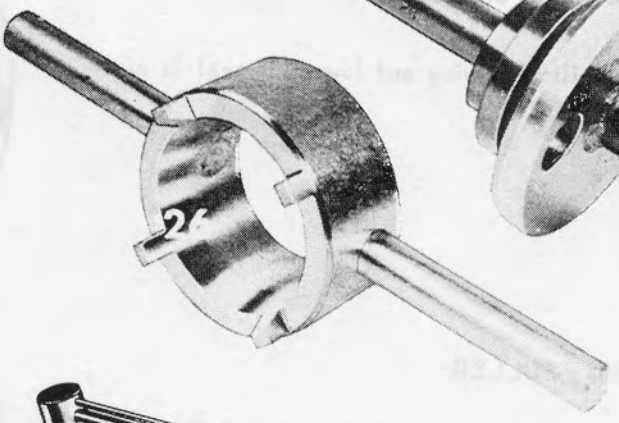
To shim gear case pinion gear.



25. C-91-52137 - SHIM TOOL

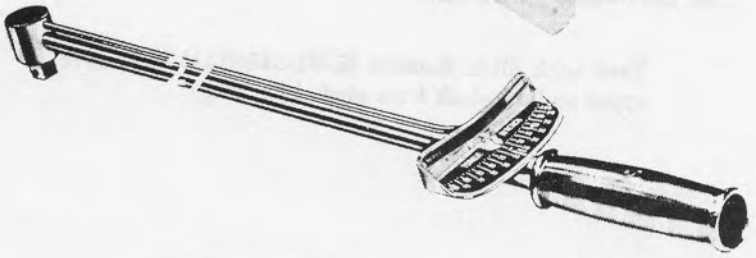
To shim drive shaft housing driven gear.





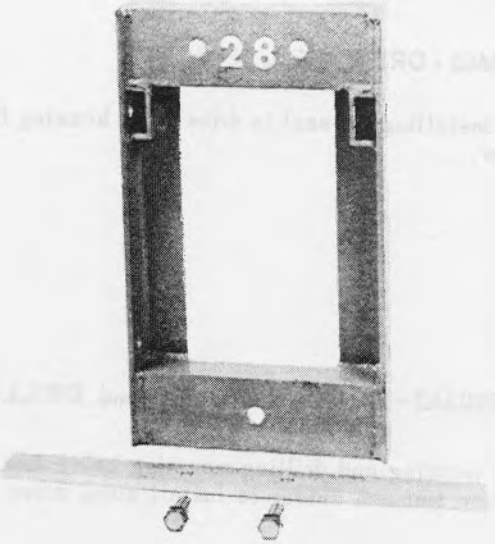
26. C-91-52141 - GEAR CASE COVER TOOL

For removal and installation of spool retainer.
(Superseded by C-91-54873)



27. C-91-52523 - TORQUE WRENCH (300 Ft. Lbs.)

To tighten large locking nuts and retainer.

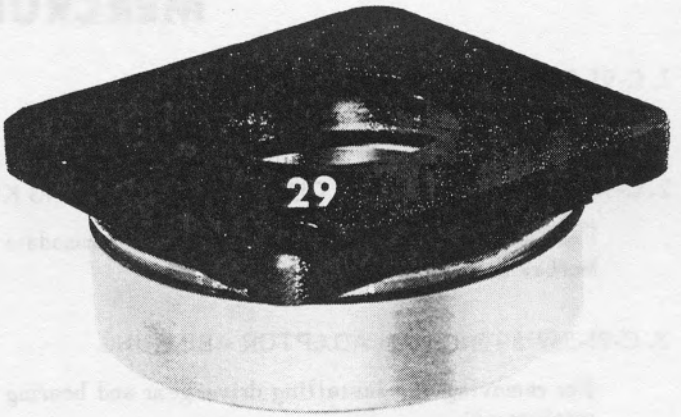


28. C-91-52569A1 - ADAPTOR, REPAIR STAND

Used with stern drive Repair Stand (C-91-33750) to hold gear housing or drive shaft housing.

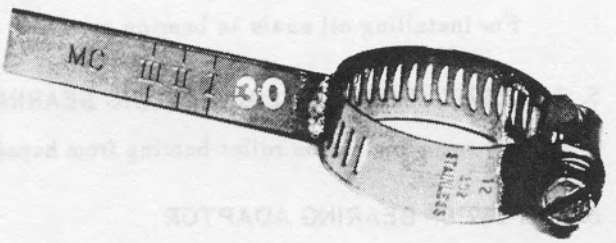
29. C-91-53118A1 - RETAINER TOOL

To center U-joint shaft and prevent drive shaft housing damage.



30. C-91-53459 - BACKLASH INDICATOR ROD

For checking gear backlash.



31. C-91-57797A3 - ENGINE ALIGNMENT TOOL
MerCruiser 110-thru-390

The tool fits thru the gimbal housing assembly for positive alignment of engine coupling to drive unit shaft.

MERCRUISER 215 DRIVE

1. C-91-54873 - SPOOL RETAINER TOOL

   For removing and installing spool retainer.

2. C-91-55852A2 - TRANSOM CUTOUT and DRILLING KIT

   For cutting opening in boat transom to accommodate MerCruiser 215 drive unit.

3. C-91-55915 - WRENCH ADAPTOR - BEARING

   For removing and installing drive gear and bearing retainer nut.

4. C-91-55916 - DRIVER, GEAR HOUSING BEARING

   For installing oil seals in bearing carrier.

5. C-91-55917 - DRIVER, GEAR HOUSING BEARING

   For removing pinion roller bearing from housing.

6. C-91-55918 - BEARING ADAPTOR

   For installing needle bearings in bearing carrier.

7. C-91-55919 - SLEEVE, SEAL and NEEDLE BEARING

   For removing seals and needle bearing in bearing carrier.

8. C-91-55920 - DRIVER, CUP - GEAR HOUSING ROLLER BEARING

   For installing gear housing roller bearing cup.

9. C-91-55921 - DRIVER, CUP - CARRIER ROLLER BEARING

   For driving roller bearing from inside of bearing carrier.

10. C-91-55922 - BEARING ADAPTOR, GEAR HOUSING

    For replacing pinion roller bearing.

11. C-91-55923 - DRIVER, U-JOINT OIL SEAL

    Presses universal joint oil seal into housing.

12. C-91-55924 - DRIVER - BEARINGS and SEAL, LOWER SWIVEL SHAFT

    To install lower swivel shaft bearing and seals in gimbal ring.

13. C-91-55925 - DRIVER - BEARINGS and SEALS, UPPER SWIVEL SHAFT

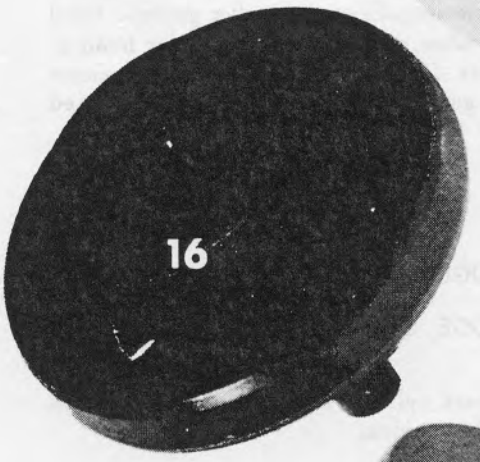
    To install upper swivel shaft bearings and seals in gimbal housing.

14. C-91-55934 - DRIVER, CUP

For installing drive shaft housing driven gear bearing cup.

15. C-91-56032 - DRIVER, GEAR BEARING

For removing needle bearings in front gear assembly.



16. C-91-56043 - SHIMMING TOOL, GEAR CASE PINION

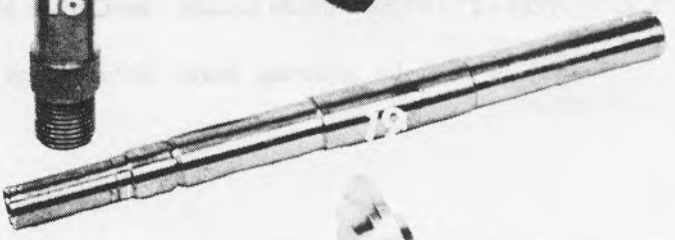
For checking pinion gear shimming.

17. C-91-56044 - SHIMMING TOOL - DRIVE SHAFT HOUSING

To shim drive shaft housing driven gear.

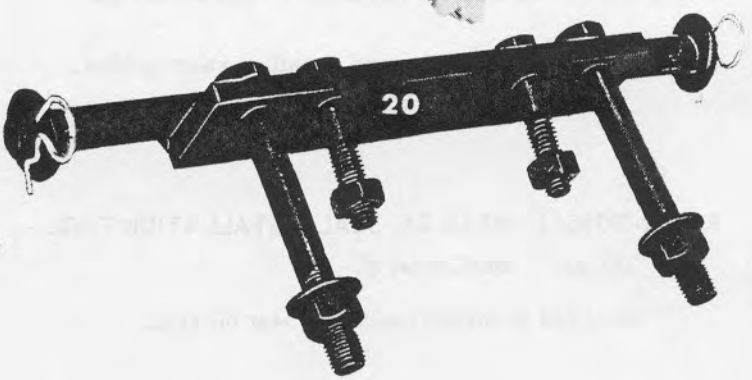
18. C-91-57795 - CLUTCH PLATE ALIGNMENT TOOL

To re-align MerCruiser Marine 215E clutch plate.



19. C-91-57797A1 - ENGINE ALIGNMENT TOOL

To align engine before installing drive unit.
(Superseded by C-91-57797A2)
(Superseded by C-91-57797A3)



20. C-91-60524A1 - ADAPTOR REPAIR STAND

Used with stern drive Repair Stand (C-91-33750) to hold gear housing or drive shaft housing.

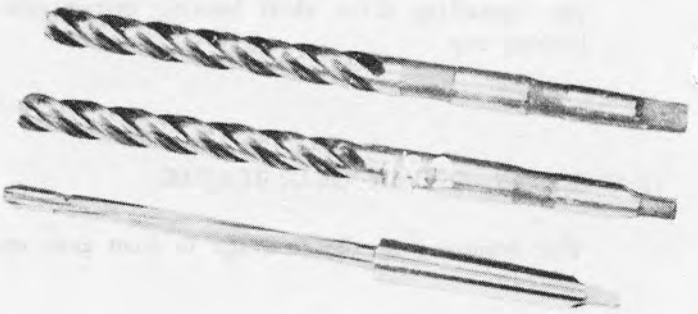
21. C-91-60697 - LONG 9/64" HEX KEY

Removes and replaces shifter gear stop screw in MerCruiser 215E Stern Drive Unit when selecting propeller shaft rotation.

MERCRUISER 60-80-90 ENGINE

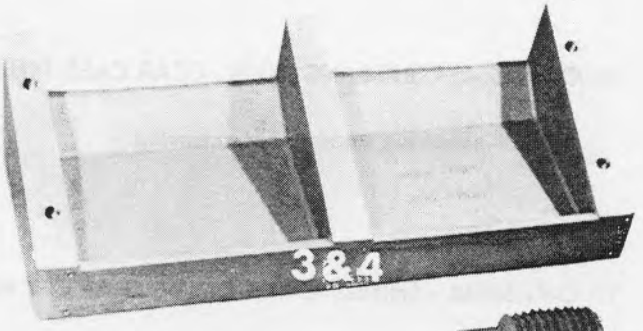
1. C-91-37002A1 - REAMER SET - MerCruiser 60
2. C-91-46777 - REAMER SET - MerCruiser 80

Required when installing new valve guides. Used for reaming valve guide holes in cylinder head to obtain correct fit and re-sizing inside diameter (ID) of new guides after they have been pressed into head.



3. C-91-37023 - WEDGE, CYLINDER HEAD - MerCruiser 60
4. C-91-46803 - WEDGE, CYLINDER HEAD - MerCruiser 80

Used to support cylinder head when removing and installing valve guides.



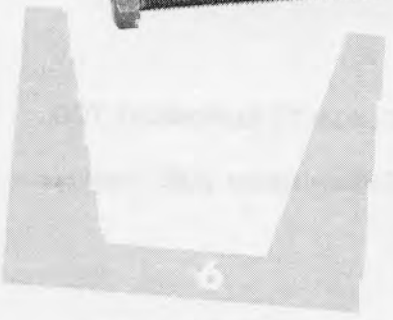
5. C-91-38835A1 - FLYWHEEL PULLER - MerCruiser 60

Required to remove alternator flywheel from crankshaft.

C-10-38836 - Replacement Screw

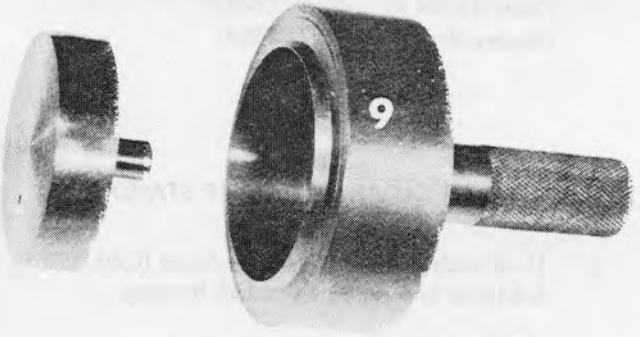
6. C-91-39123 - STARTER PINION GAUGE - MerCruiser 60

Tool is used for adjusting starter motor pinion travel.



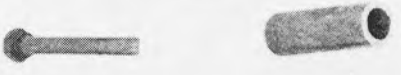
7. C-91-39284A1 - MANDREL ASSEMBLY - MerCruiser 60
8. C-91-46773 - MANDREL ASSEMBLY - MerCruiser 80

Required for removing and installing valve guides.



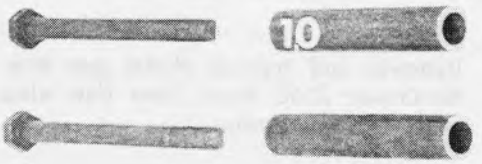
9. C-91-39285A1 - REAR OIL SEAL INSTALLATION TOOL - (NLA) MerCruiser 60

Required to install crankshaft rear oil seal.



10. C-91-45022A1 - ENGINE MOUNTING KIT

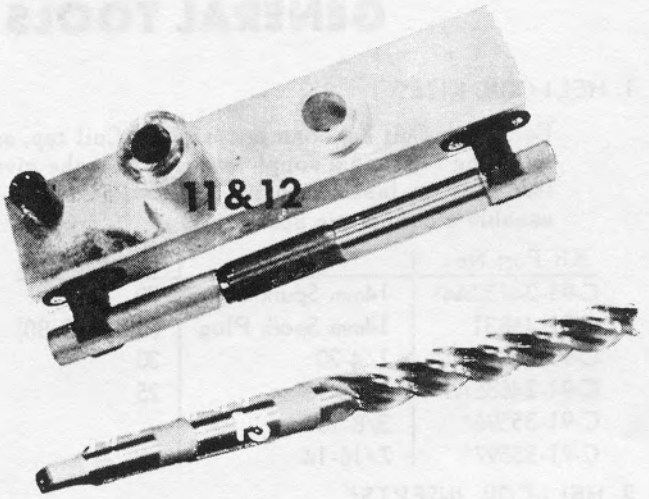
Contains necessary bolts for mounting engines to service stand.



11 .C-91-39288A1 - PISTON PIN TOOL - MerCruiser 60

12. C-91-46771 - PISTON PIN TOOL - MerCruiser 80

Required for removing and installing piston pins.



13. C-91-46778 - REAMER - MerCruiser 80

Required for reaming cylinder head valve lifter holes when installing oversize valve lifters.

14. C-91-46956 - CYLINDER HEAD ALIGNING TOOL - MerCruiser 80

Required to align cylinder head and block when installing head.

15. C-91-47160 - VALVE ADJUSTING TOOL - MerCruiser 80

Used when adjusting valve-rocker arm clearances.

GENERAL TOOLS for ALL MERCRUISERS

1. HELI-COIL KITS*

Each Heli-Coil Kit contains one Heli-Coil tap, one inserting tool and a supply of inserts for the given thread, plus instruction pamphlet. Packed in re-useable clear plastic boxes.

Kit Part No.	Size	No. of Inserts
C-91-24133A4*	14mm Spark Plug	20
C-91-45831	14mm Spark Plug	(MC 60 & 80)
C-91-24682A1*	1/4-20	30
C-91-24686A1*	5/16-18	25
C-91-35596*	3/8-16	--
C-91-35597*	7/16-14	--

2. HELI-COIL INSERTS*

C-91-24682*	¼ - 20 x 3/8"
C-91-24683*	¼ - 28 x 3/8"
C-91-24686*	5/16 - 18 x 13/32"
C-91-24691*	3/8 - 16 x ½"
C-91-45831*	14mm
C-91-29410*	14mm
C-91-48778	7mm
C-91-48779	8mm

3. REPLACEMENT PIECE*

NOTE: Order the separate replacement piece, if you already have the Heli-Coil kits:

Part No.	Description
C-91-24142*	Heli-Coil Tap 5/16 x 18

4. C-91-25213* - MAGNETO ANALYZER

For testing electrical components on MerCruiser Marine Engines. Analyzer is used for testing ignition coils, condensers, resistors, continuity and resistance. Tester is portable and requires 110-volt current only when testing condensers. Instruction manual included with Analyzer.

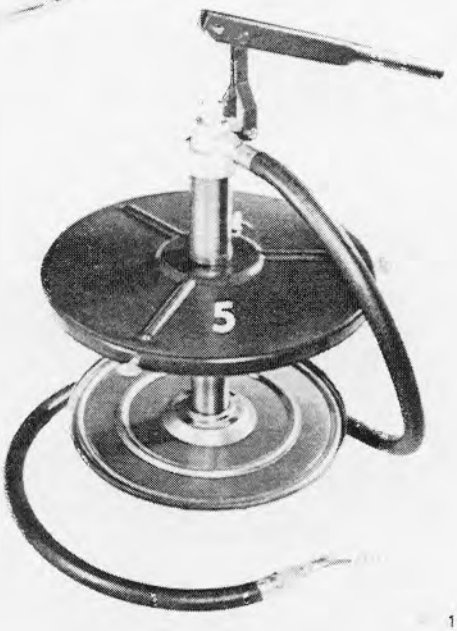
Coil - High and low speed . . . Coil continuity . . Insulation leakage . . . Primary test.

Condenser - Capacity test . . . Leakage and short. Also times motor . . . Spark plug test . . . Distributor resistance test . . . Continuity of electrical parts . . . Breaker point resistance.

C-91-35540* - Battery, Analyzer (7½ Volt)

Use in conjunction with C-91-25213*.

5. C-91-26150* - PORTABLE LUBRICANT GUN and HOSE



A portable grease lubricant gun with 5 ft. (1.524m) hose and a non-drip nozzle. Gun attaches quickly and easily to the 25 lb. (11.340kg) container of Kiekhaefer Super-Duty Quicksilver Gear Lubricant (C-92-56565-1) for easy filling of gear housing on all models.

Gun incorporates a machined piston which assures maximum lubricant output per stroke. It is rust-proof and finished in high gloss . . . . . gun-metal blue.

6. C-91-27883* - AMPERE-VOLT TESTER
(NL A)

A new electrical test instrument to check DC current output of generating system, battery drain and DC voltage check of battery on all models. Complete test instructions are included with each unit.

7. C-91-28993 - SPRING TENSION SCALE

Spring Tension Scale for checking the bearing pre-load and also for checking breaker spring tension.

8. C-91-30500 * - LUBRICANT GUN

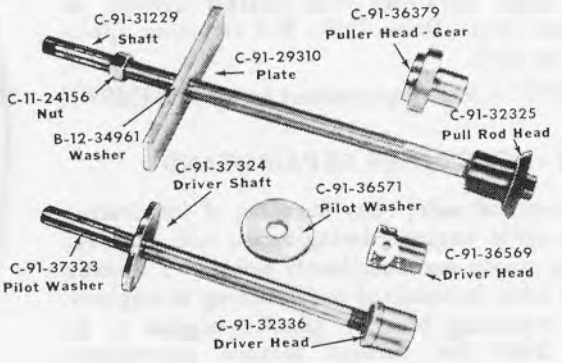
Use with New Multipurpose Lubricant (C-92-49588*)

9. C-91-31229A3* - KIT, BEARING REMOVAL and INSTALLATION

(Superseded by C-91-31229A4)

NOTE: Do not order individual tools if C-91-31229A3 is ordered.

C-11-24156* - Nut, puller (MerCr. I-II)
B-12-34961* - Washer, puller (MerCr. I-II)
C-91-29310* - Plate, puller (MerCr. I-II)
C-91-31229* - Shaft, puller (MerCr. I-II)
C-91-32325* - Pull Rod Head (MerCr .II)
C-91-32336* - Driver Head (MerCr .II)
C-91-36379* - Puller Head (MerCr .II)
C-91-36569* - Driver Head (MerCr. I)
C-91-36571* - Washer, pilot (MerCr. I)
C-91-37263* - Adaptor, bearing (MerCr .I)
C-91-37323* - Rod, driver (MerCr .O-I-II)
C-91-37324* - Washer, pilot (MerCr. II)
C-91-38628* - Puller Head (MerCr. IA-IB-IC)



10. C-91-31591* - SERVICE TACHOMETER and DWELL METER

Will show engine RPM (range 0-to-10,000) on both 2 and 4-cycle engines. Dwell Meter is used for checking and adjusting breaker point dwell on all battery ignition systems. Instrument is completely portable.

(superseded by C-91-59339)

11. C-91-31800* - MAGNETO ANALYZER (220 Volt, 50 Cycle)

For testing electrical components on MerCruiser Marine Engines. Analyzer is used for testing ignition coils, condensers, resistors, continuity and resistance.

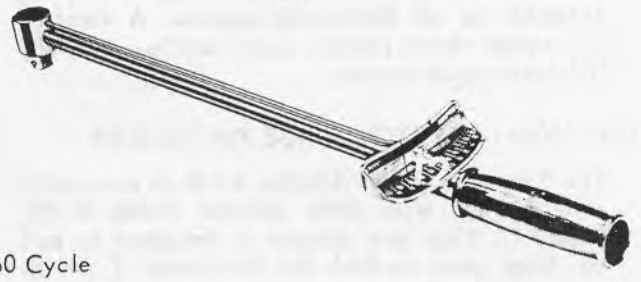
Tester is portable and requires 220-volt current only when testing condensers Instruction manual included with Analyzer.

C-91-35540 - Battery, Analyzer (7½ Volt)

(Export, except Canada. PLEASE SPECIFY VOLTAGE)

240 Volt, 50 Cycle
250 Volt, 50 Cycle
220 Volt, 50 Cycle
230 Volt, 50 Cycle

(See C-91-25213 for illustration.)*



12. C-91- 32610*- TORQUE WRENCH

½" (12.7mm) square drive, 200 ft. lbs. (27.6mkg) maximum reading.

13. C-91-32881* - MAGNETO ANALYZER (Canada) - 110V, 60 Cycle

(Superseded by C-91-25213)

14 . C-91-33686 - ADJUSTMENT WORK STAND

Can be used with vise or MerCruiser repair stand. Adjusts to various heights for working ease.

15. C-91-33750 - MERCRUISER REPAIR STAND

For servicing MerCruiser I and II Drive Units. Unit can be located in various positions for working ease. Used in conjunction with C-91-33686 Adjustable Work Stand.

16. C-91-34429 - CRANKCASE OIL DRAIN PUMP

For removing crankcase oil from all MerCruiser Marine Engines. Pump pickup tube fits down thru engine dip stick tube.

17. C-91-34569A1* - PULLER, SLIDE HAMMER

For removing all tapered roller bearing cups and reverse gear assembly from bearing carrier on MerCruiser Stern Drive Unit. Will fit other applications as well.

C-91-34570* - Jaw (replacement for C-91-34569A1)

18. C-91-35135 - MERCRUISER REPAIR STAND

The answer for safe, easy handling of MerCruiser I & II 4-cycle engines during repair and overhaul . . . very sturdy and completely mobile . . . saves time and labor in repairing and handling of engines. Engine mounting bracket permits engine to be rotated 360° for various service operations.

C-91-45022A1 - MerCruiser "60" Engine Mounting Kit. Used in conjunction with C-91-35135.

19. C-91-35507A1 - TIMING LIGHT

Accurately "times" any 2 or 4-cycle engine with 6 or 12-volt DC system. Molded plastic case virtually unbreakable, lightweight, modern design. Operates without "spark lag" throughout entire RPM range, from idle position to wide-open throttle.

20. C-91-35540 - BATTERY, ANALYZER (7½ Volt)

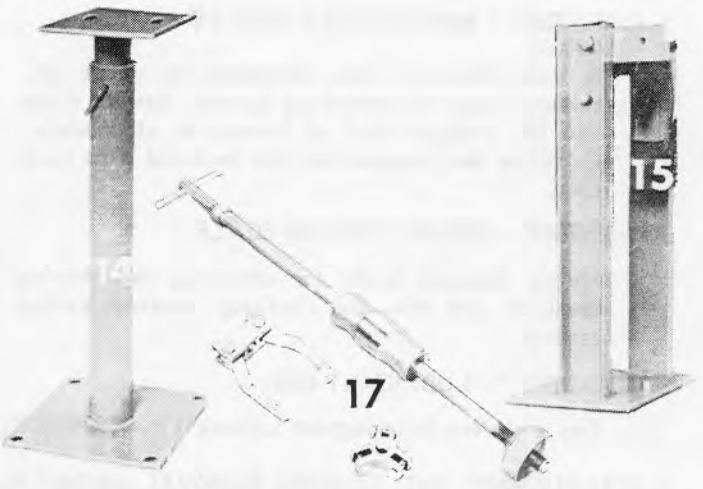
For testing electrical components on MerCruiser Marine Engines. Analyzer is used for testing ignition coils, condensers, resistors, continuity and resistance. Tester is portable and requires 110-volt current only when testing condensers. Instruction manual included with Analyzer.

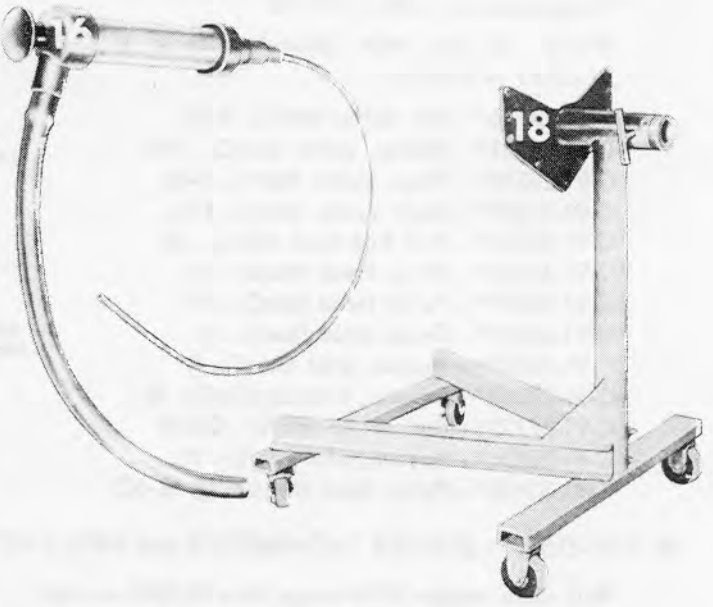
21. C-91-35547 - ENGINE COUPLING WRENCH

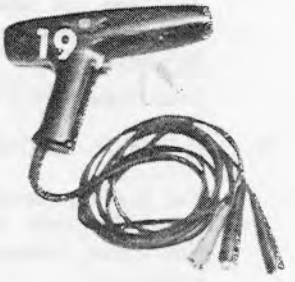
For removing and installing the engine coupling assembly on all MerCruiser engines. A standard ½" square drive permits easy torquing with any ½" drive torque wrench.

22. C-91-36060 - ADAPTOR, HINGE PIN PULLER

The Hinge Pin Puller Adaptor, ¼ x 28 is now available for use with Slide Hammer Puller (C-91-34569A1). This new adaptor is designed to pull the hinge pins on both the MerCruiser I and II.







23. C-91-36392 - UNIVERSAL CARBURETOR GAUGE

Clevis design gives full visibility of both scales which is essential when setting gauge to exact specification . . . plus many other service operations. Eliminates the need for special gauges for each make and model.

24. C-91-37240A1 - SNAP RING PLIERS

For removing and installing the snap rings on MerCruiser Stern Drive Units. Pliers has two extra sets of removable tips.

25. C-91-37241 - UNIVERSAL PULLER PLATE

For pulling gears and bearings on MerCruiser I & II. The "knife-like" egdes of puller plates may be forced behind the part. The finest alloy steels and expert heat treating assures unequaled strength. This plate supersedes previous puller plates.

26. C-91-37299* - PISTOLUBER GREASE GUN

Squeeze-grip design permits one hand operation. High pressure 12" flexible hose allows easy access to grease fittings on outboards and stern drive units. New Multipurpose Lubricant (C-92-49588) tube screws directly on grease gun.

27. C-91-37681A1 - SHOCK ABSORBER CAP WRENCH - MerCruiser I

For installing shock absorber spacers when installing Power Tilt on earlier MerCruiser I drive units.

28. C-91-38053A1 - PRESSURE GAUGE ASSEMBLY (HYDRAULIC)

Used when making adjustment of MerCruiser Power Steering cylinder and steering cable.

29. C-91-38756 - ADAPTOR, UNIVERSAL JOINT

To support yoke when disassembling MerCruiser universal joints.

30. C-91-39212* - TIMING LEAD

Used to connect timing lite between spark plug and spark plug protector.

31. C-91-46086A1 - BEARING CARRIER PULLER

Used in conjunction with slide hammer to remove bearing carrier from gear housing.

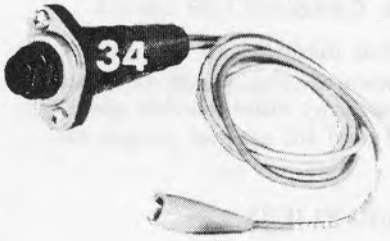
32. C-91-46802A1 - MERCATHODE TESTER (NLA)
Tests/monitors MerCathode System.

33. C-91-49700A2 - TACHOMETER TESTER (For Thunderbolt Ignition)

Checks the recommended calibration point of Tachometers C-91-45294A_ and C-48168A_, giving instant information on the tachometer's condition. The tester comes complete, less batteries. Three 9-volt transistor batteries -- such as Eveready 216, Burgess 2U6, Ray-O-Vac 1504 or RCA US323 -- are required.

34. C-91-52024A1 - REMOTE STARTER SWITCH

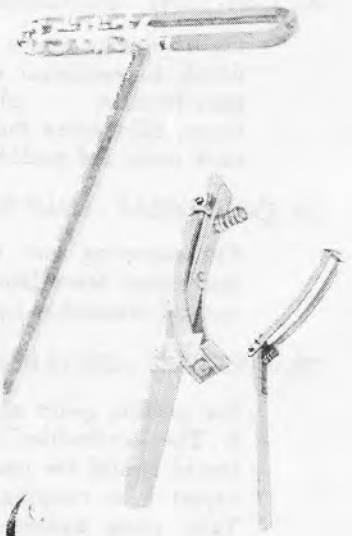
Used for remote starting of engines when setting timing or troubleshooting.



35. C-91-52340* HEX KEY WRENCH, TRIM TAB (5/16")
(NLA)

36. C-91-52341* HEX KEY WRENCH, TRIM TAB (3/8")
(NLA)

Wrenches will adjust or remove and replace trim tab.



37. C-91-52344* - FLYWHEEL HOLDING TOOL

Tool is designed for turning the flywheel while making engine repairs.

38. C-91-52751 - V-O-A (Volt-Ohm-Ampere) TESTER

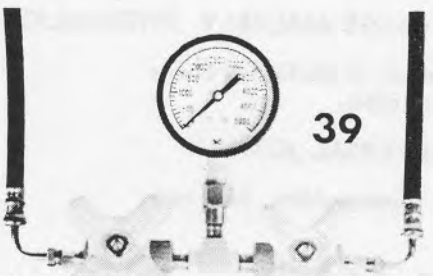
Tests Thunderbolt Ignition and transistorized circuitry.

39. C-91-52915A2 - HYDRAULIC PUMP -
TEST GAUGE ASSEMBLY

For field testing hydraulic pumps.

40. C-91-53459 - BACKLASH INDICATOR ROD

For checking gear backlash.

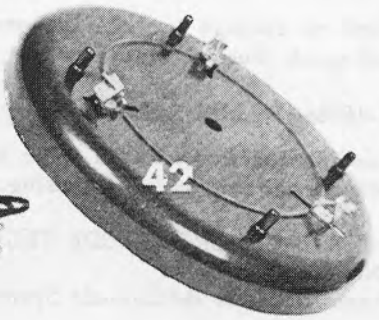


41. C- 55585 - FLUSH TEST DEVICE

For cooling engine when running out-of-water.

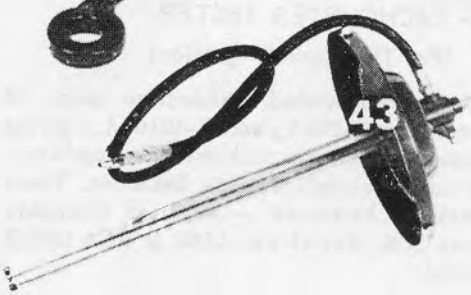
42. C-91-56979 - DOLLY, 120 LB.. DRUM

For supporting 120 lb. oil drum.



43. C-91-56982 - HAND PUMP, 120 LB. DRUM

For pumping oil from drum.



44. C-91-59339 TACHOMETER and DWELL METER

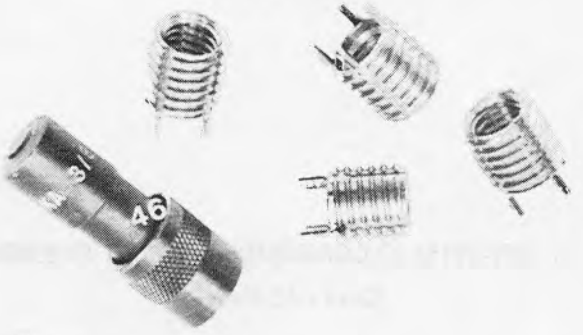
Will show engine RPM (range 0-to-10,000) on both 2 and 4-cycle engines. Dwell meter is used for checking and adjusting breaker point dwell on all battery ignition systems.

45. KEENSERT KITS

Kit Part No.	Kit Description	Contents of Kit
C-91-59964	Spark Plug Master Kit	20 alum. spark plug inserts, 14mm, ½" reach & install. tools
C-91-59976	¼-20 Thread Repair Kit	8 stainless steel ¼-20 inserts and installation tool
C-91-59983	5/16-18 Thread Repair Kit	5 stainless steel 5/16-18 inserts and installation tool
C-91-59990	3/8-16 Thread Repair Kit	4 stainless steel 3/8-16 inserts and installation tool

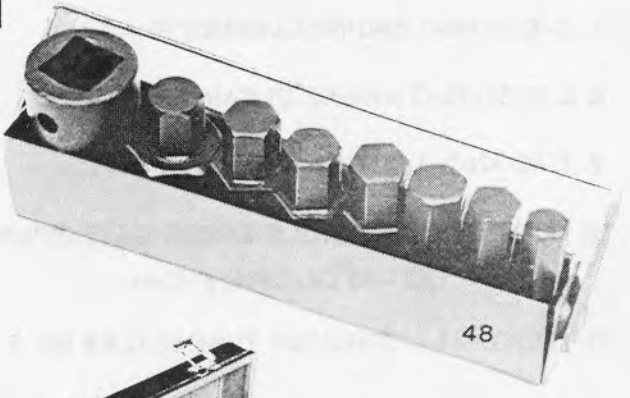
46. KEENSERT REFILL KITS

Kit Part No.	Kit Description	Contents of Kit
C-91-59970	Spark Plug Refill Kit	10 alum. spark plug inserts and rings 14mm, ½" reach
C-91-59980	¼-20 Refill Kit	25 stainless steel ¼-20 inserts
C-91-59988	5/16-18 Refill Kit	15 stainless steel 5/16-18 inserts
C-91-59996	3/8-16 Refill Kit	12 stainless steel 3/8-16 inserts



47. C-91-60688 - POINTS, SNAP RING PLIERS

Replacement points for Snap Ring Pliers (C-91-37240A1) which are used to remove and replace gimbal bearing snap rings.



48. C-91-60699 - HEX DRIVER KIT

Used for removal of hex socketed hinge pins and plugs on MerCruiser Power Packages. Kit includes hex fits 5/16", 3/8", 7/16", 9/16", 5/8" and 3/4" with a 1/2" drive and storage tray.

49. C-91-62563A1 - THUNDERBOLT IGNITION ANALYZER

It will troubleshoot, test and eliminate defective components in all Mercury Marine Thunderbolt Ignition Systems.

LUBRICANTS & ADHESIVE SEALERS

1. C-92-24108-1 COMPOUND (DC4)

2. C-92-25234-1 - GLUE

Used to hold various "O" rings and gaskets in position on gimbal housing during installation.

3. C-92-25711-1 - NEOPRENE (½ Pint)

All models.
Seals electrical connections to prevent corrosion.

4. C-92-28143-12 - STORAGE SEAL

Case of 12 - 8 Oz. Cans
(Superseded by C-92-54778-12)

6. C-92-29152-12 CORROSION and RUST PREVENTIVE

Case - 12 Cans

7. C-92-30140-1 ENGINE CLEANER (Gal. Can)

8. C-92-32172-12 MARINE CLEANER (Case of 12)

9. C-92-32609-1 LOCTITE TYPE "A" (10cc)

10. C-92-33365-12 - 4-CYCLE ENGINE OIL SUPPLEMENT

12 - 16 Oz. (.454kg) Cans

11. C-92-33749-1 - EXHAUST TUBE SEALER NO. 2

12. C-92-34227-1 - PERFECT SEAL NO. 4

16 Oz. (.454kg) Can

13. C-92-34249-12 - CARBURETOR CONDITIONER

12 Oz. (.355kg) Can
(Superseded by C-92-58280-12)

14. C-92-36204-1 - BALL BEARING LUBRICANT

13 Oz. (.369kg) Tube

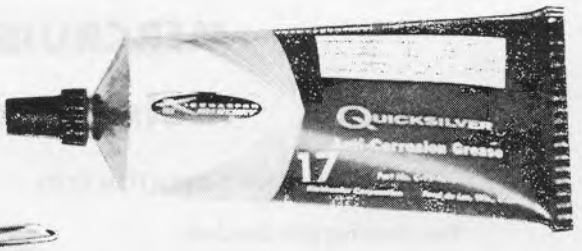
15. C-92-36340A1 - BELLOWS ADHESIVE

16. C-92-39928A12 - ANTI-CORROSION OIL

Specially processed to provide a good lubricating coating for all external moving surfaces.

17. C-92-45134A12 - ANTI-CORROSION GREASE

Specially processed to provide a good lubricating coating for all external moving surfaces.



18. C-92-47949-12 ENGINE CLEANER
Case of 12 - 16 Oz. Cans

19. C-92-49588-12 MULTIPURPOSE LUBRICANT
Case - 12 Tubes

All models. For lubrication of external parts . . . high dielectric qualities . . . 8 oz. tube.

20. C-92-52238-1 - SILICONE SEAL
3 Oz. Tube

21. C-92-52645-1* - SUPER-DUTY GEAR LUBE
One 25 Lb. Pail

(Superseded by C-92-56565-1, 37 lb. Pail)
Highest quality lower unit gear lubricant.

22. C-92-52650-12* - SUPER-DUTY GEAR LUBE
12 - 8 Oz. (.227kg) Tubes

23. C-92-52655-12* - SUPER DUTY GEAR LUBE
12 - 1 Qt. (.946 Liter) Cans

24. C-92-56101-1 - SUPER DUTY GEAR LUBE
120 l.b. (16 Gal.) Drum

Highest quality lower unit gear lubricant.

25. C-92-58229-1 - UNIVERSAL JOINT LUBRICANT

Especially compounded for lubricating universal joint cross and bearings.

26. C-92-59327-1 - LOCQUIC PRIMER GRADE "T"
6 Oz. of Primer

Used in conjunction with Loctite to accelerate curing speeds.

27. C-92-59328-1 - NO.35 LOCTITE

28. C-92-59957-1 - LUBRICANT ADDITIVE
4 Fl. Oz.

To eliminate rocker ball and arm squeak on 4-cycle engines.

MERCRUISER II-TR DRIVE TOOLS

Tools Used on Other Drive Units

1. C-91-53459 - BACKLASH INDICATOR ROD

   For checking gear backlash.

2. C-91-54873 - SPOOL RETAINER TOOL

   To remove and install gear housing spool retainer.

3. C-91-55852A2 - TRANSOM CUTOUT and DRILLING KIT

   Aids when cutting opening in boat transom to accommodate MerCruiser 225-255 TR drive unit.

4. C-91-55916 - DRIVER, OIL SEAL

   For installing oil seals in bearing carrier.

5. C-91-55918 - BEARING ADAPTOR

   For installing needle bearing in bearing carrier.

6. C-91-55919 - DRIVER BEARING and SEALS

   For removing seals and needle bearing in bearing carrier.

7. C-91-55924 - DRIVER, BEARING and SEAL

   To install lower swivel shaft bearing and seals in gimbal ring.

8. C-91-55925 - DRIVER, BEARINGS and SEALS

   For installing upper swivel shaft bearings and seals in gimbal housing.

9. C-91-57797A3 - ENGINE ALIGNMENT TOOL

   (Superseded by C-91-57797A1)

   To align engine before installing drive unit.

10. C-91-60524A1 - ADAPTOR, REPAIR STAND

    Used with stern drive Repair Stand (C-91-33750) to hold gear housing or drive shaft housing.

Tools Used on MerCruiser II-TR Drive Only

1. C-91-63616 - PULLER, LOWER DRIVE SHAFT

   For pulling drive shaft from gear housing.

2. C-91-63618 - SHAFT ADAPTOR, ENGINE ALIGNMENT

   To be used with C-91-57797A1 Alignment Shaft Assembly for engine alignment.

   NOTE: Do not order C-91-63618 Shaft Adaptor if C-91-57797A3 Alignment Shaft is ordered.

3. C-91-63619 - DRIVER, BEARING and SEAL INSTALLATION TOOL

   For installing drive shaft bearing cup and universal joint oil seal in drive shaft housing.

4. C-91-63620A1 - BEARING NUT WRENCH and DRIVE SHAFT SOCKET

   For removing and installing upper drive shaft bearing nut.

5. C-91-63622 - SHIMMING TOOL, GEAR HOUSING PINION

   For checking gear housing pinion gear shimming.

6. C-91-63623 - SHIMMING TOOL, DRIVE SHAFT HOUSING GEAR

   For checking drive shaft housing driven gear shimming.

7. C-91-63624 - SHIMMING TOOL, DRIVE SHAFT HOUSING PINION

   For checking drive shaft housing pinion gear shimming.

8. C-91-63625 - BEARING HOLDER

   To support drive gear bearing when removing universal joint nut.

9. C-91-63626 - DRIVER, BEARING CUP

   For installing front propeller shaft bearing cup in gear housing, bearing cup in bearing carrier and driven gear bearing cup in drive shaft housing.

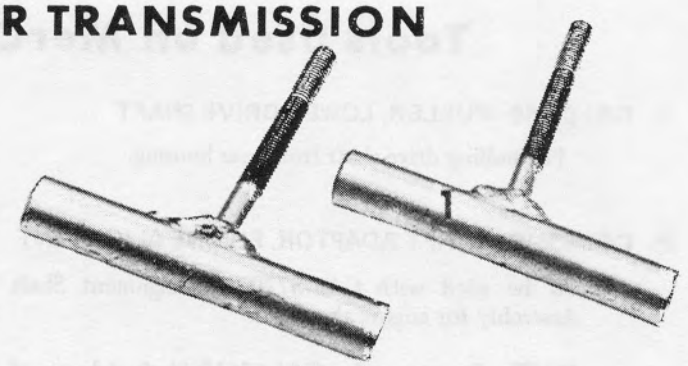
10. C-91-63638 - DRIVER, BEARING

    For removing and installing lower drive shaft pinion bearing.

MERCRUISER II-TR TRANSMISSION

C-91-65307A1 - KIT, MERCRUISER II-TR TRANSMISSION

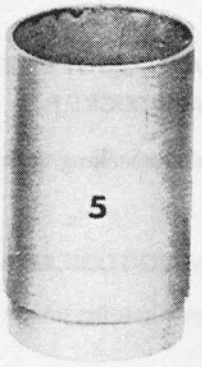
NOTE: Transmission tools are available in kit ONLY. Tools are not sold separately. Kit consists of the following:



1. Tee Handles - Used for removing and installing pump housing assembly.

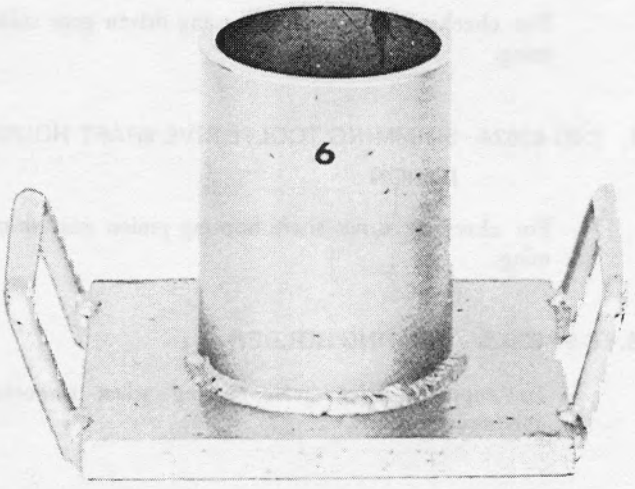
2. Seal Ring Compressor - To compress teflon seal rings on output shaft of transmission.

3. Seal Ring Installing Tool - Used to install teflon seal rings on output shaft.



4. Taper Plug - Aids installation of teflon seal rings onto installing tool.

5. Piston Housing Compressor - Used with a press to remove and install snap rings in the control valve housing and planetary gear assembly.



6. Planetary Holding Fixture - To hold the planetary gear assembly during repair.